

# Fairness in Information Retrieval

- SI 650 / EECS 549  
Nov. 12, 2025

Slides adapted from David Jurgenens  
Some slides from Lisa Hoover, Christo Wilson,  
Julian McAuley, Piotr Sapiezynski

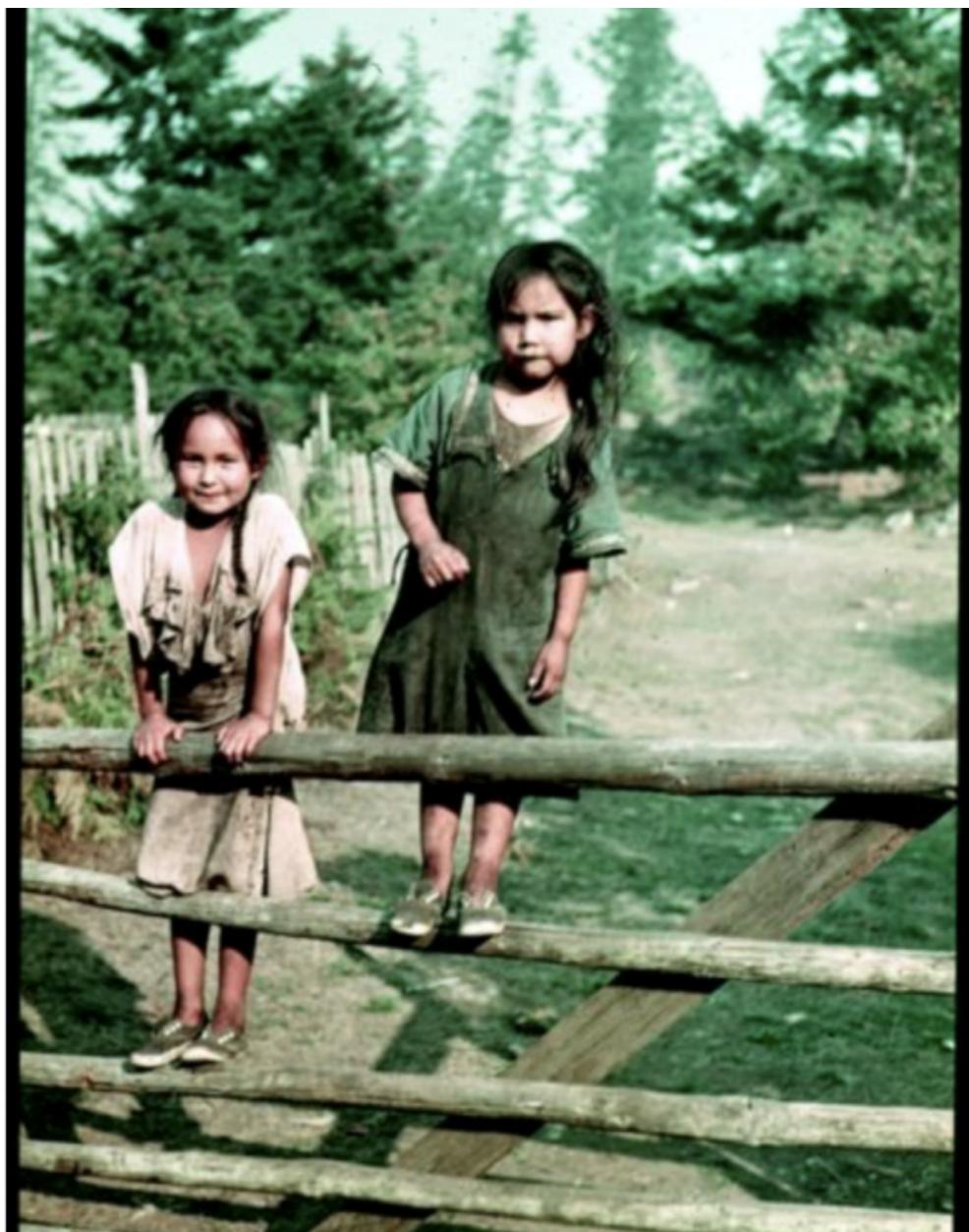
# Announcements

- Late days: You can't use late days for the project reports
- Exam: Accommodation Room announced. Let us know if you have concerns asap.

# Today's goals

- Old school IR: Fairness in Archives
- Personalization in IR—what data might be used?
- Fairness issues in web search and IR
- Human-in-the-loop discovering of disparity
- Recommendation Systems

# Issues in Information Categorization



<b>Archives ID:</b>	P01454
<b>Date:</b>	Sep. 1938
<b>Description (Slide):</b>	43= Two little Indians - Vancouver Island
<b>Description (Notebook):</b>	* C-43: 3 little Indians enjoy Jean's / Iums
<b>Street Address:</b>	(None)
<b>Location:</b>	<a href="#">British Columbia, Canada</a> ( <a href="#">Vancouver Island county</a> )
<b>Camera Settings:</b>	(None)
<b>Roll Number:</b>	<a href="#">3-38</a>
<b>Frame Number:</b>	43
<b>Personal Names:</b>	(None)
<b>Corporate Names:</b>	(None)
<b>Other Names:</b>	(None)
<b>Genre Headings:</b>	<a href="#">Portraits</a> ; <a href="#">Ethnographic photographs</a>
<b>Subject Headings:</b>	<a href="#">Indians of North America</a> <a href="#">Trees</a> <a href="#">Fences</a> <a href="#">Shrubs</a> <a href="#">Gates</a> <a href="#">Girls</a>
<b>Other Subject Headings:</b>	(None)

Charles W. Cushman Photograph Collection, Indiana University Libraries.  
<http://purl.dlib.indiana.edu/indl/archives/cushman/P01454>

# Dewey Decimal Classification

Dewey Numbers	Dewey Main Category	Books in this Category Answer this Question
000 - 099	General Information	How do we organize information?
100 - 199	Philosophy & Psychology	Who am I?
200 - 299	Religion	How did we get here?
300 - 399	Social Sciences	Who are the people around me?
400 - 499	Language	How can I communicate with others?
500 - 599	Science	How can I explain the world around me?
600 - 699	Technology	How can I control the world around me?
700 - 799	Arts & Recreation	How can I enjoy my free time?
800 - 899	Literature	What are the stories of our lives?
900 - 999	History & Geography	What was the world like in the past? What is it like now?

# Dewey Decimal Classification

320 Political science	<ul style="list-style-type: none"><li>● 320 Political science<ul style="list-style-type: none"><li>○ 320.1 The state</li><li>○ 320.3 Comparative</li><li>○ 320.4 Structure and functions of government</li><li>○ 320.5 Political ideologies</li><li>○ 320.8 Local government</li><li>○ 320.9 Political situation and conditions</li><li>○ 320.971 Politics of Canada</li></ul></li><li>● 321 Systems of governments &amp; states<ul style="list-style-type: none"><li>○ 321.4 Pure democracy</li><li>○ 321.5 Elitist systems</li><li>○ 321.8 Democratic systems</li><li>○ 321.9 Authoritarian systems</li></ul></li><li>● 322 Relation of state to organized groups<ul style="list-style-type: none"><li>○ 322.4 Political action groups</li></ul></li><li>● 323 Civil &amp; political rights<ul style="list-style-type: none"><li>○ 323.1 Civil rights of non-dominant aggregates, political rights of nondominant aggregates</li><li>○ 323.3 Civil and political rights of other social aggregates</li><li>○ 323.4 Specific civil rights; limitation and suspension of civil rights</li><li>○ 323.5 Political rights</li><li>○ 323.6 Citizenship and related topics</li></ul></li><li>● 324 The political process<ul style="list-style-type: none"><li>○ 324.1 International party organizations, auxiliaries, activities</li><li>○ 324.2 Political parties</li><li>○ 324.5 Nomination of candidates</li><li>○ 324.6 Election systems and procedures; suffrage</li><li>○ 324.7 Conduct of election campaigns</li><li>○ 324.9 Historical and geographic treatment of elections</li></ul></li><li>● 325 International migration &amp; colonization</li><li>● 326 Slavery &amp; emancipation</li><li>● 327 International relations<ul style="list-style-type: none"><li>○ 327.1 General topics of international relations; spies</li><li>○ 327.2 Diplomacy</li></ul></li><li>● 328 The legislative process<ul style="list-style-type: none"><li>○ 328.2 Initiative and referendum</li><li>○ 328.3 Legislative bodies</li></ul></li><li>● 329</li></ul>
-----------------------	---

[http://bpeck.com/references/DDC/ddc\\_mine300.htm](http://bpeck.com/references/DDC/ddc_mine300.htm)

# Dorothy Porter



Dorothy Porter in 1939 at her desk in the Carnegie Library at Howard U

<https://www.smithsonianmag.com/history/remembering-howard-university-librarian-who-decolonized-way-books-were-catalogued-180970890/#JieOTpY6TRCka6uM.99>

“Now in [that] system, they had one number—326—that meant slavery, and they had one other number—325, as I recall it—that meant colonization,” she explained in her oral history. In many “white libraries,” she continued, “every book, whether it was a book of poems by James Weldon Johnson, who everyone knew was a black poet, went under 325. And that was stupid to me.”

Consequently, instead of using the Dewey system, Porter classified works by genre and author

# Dewey Decimal Classification

970 General history of North America	<ul style="list-style-type: none"><li>● 970 General history of North America; Natives of North America</li><li>● 971 Canada<ul style="list-style-type: none"><li>○ 971.01 To 1763</li><li>○ 971.02 1763-1791</li><li>○ 971.03 1791-1841 including the Rebellions of 1837</li><li>○ 971.04 1841-1867</li><li>○ 971.05 1867-1911 including Confederation and the Riel Rebellion</li><li>○ 971.06 1911 and following<ul style="list-style-type: none"><li>■ 971.061 1911-1921</li><li>■ 971.062 1921-1935</li><li>■ 971.063 1935-</li><li>■ 971.064</li><li>■ 971.065</li></ul></li><li>○ 971.1 History of BC</li><li>○ 971.23 Alberta</li><li>○ 971.24 Saskatchewan</li><li>○ 971.27 Manitoba</li><li>○ 971.3 History of Ontario</li><li>○ 971.4 History of Quebec</li><li>○ 971.5 History of the Maritimes; New Brunswick</li><li>○ 971.6 Nova Scotia</li><li>○ 971.7 Prince Edward Island</li><li>○ 971.8 Newfoundland</li><li>○ 971.9 The North</li></ul></li><li>● 972 Middle America; Mexico<ul style="list-style-type: none"><li>○ 972.8 Central America</li><li>○ 972.9 West Indies (Antilles) and Bermuda</li></ul></li><li>● 973 United States<ul style="list-style-type: none"><li>○ 973.1 Early history to 1607</li><li>○ 973.2 Colonial period, 1607-1775</li><li>○ 973.3 Periods of Revolution and Confederation, 1775-1789</li><li>○ 973.4 Constitutional period, 1789-1809</li><li>○ 973.5 1809-1845</li><li>○ 973.6 1845-1861</li><li>○ 973.7 Administration of Abraham Lincoln, 1861-1865Civil War</li><li>○ 973.8 Reconstruction period, 1865-1901</li><li>○ 973.9 1901-<ul style="list-style-type: none"><li>■ 973.91</li></ul></li></ul></li></ul>
--------------------------------------	--

[http://bpeck.com/references/DDC/ddc\\_mine300.htm](http://bpeck.com/references/DDC/ddc_mine300.htm)

en.wikipedia.org/wiki/Library\_of\_Congress\_Classification:Class\_E--History\_of\_America

Not logged in Talk Contributions Create account Log in

Article Talk Read Edit View history Search Wikipedia

## Library of Congress Classification:Class E -- History of America

From Wikipedia, the free encyclopedia

**Class E: History of America** is a classification used by the [Library of Congress Classification system](#). This article outlines the structure of Class E.

### E - History of America [edit]

1-912.....History of America

11-143.....[America](#)

11-29.....General

29.....Elements in the population

31-49.2.....North America

51-73.....[Pre-Columbian America. The Indians](#)

75-99.....[Indians of North America](#) ←

81-83.....Indian wars

99.....Indian tribes and cultures

101-135.....Discovery of America and early explorations

103-110.....Pre-Columbian period

111-120.....[Columbus](#)

121-135.....Post-Columbian period. [El Dorado](#)

141-143.....Descriptive accounts of America. Earliest to 1810

151-912.....[United States](#)

151-169.12.....General

[https://en.wikipedia.org/wiki/Library\\_of\\_Congress\\_Classification:Class\\_E--History\\_of\\_America](https://en.wikipedia.org/wiki/Library_of_Congress_Classification:Class_E--History_of_America)

**Preview**



[Google Preview](#)

---

**Tools**

- [Add to folder](#)
- [Cite ▾](#)
- [Export to Refworks](#)
- [Export to EndNote](#)
- [Email](#)
- [Librarian View](#)

---

**Browse by call number:**

- [Suggested techniques in guidance...](#)  
Nevada. Department of Education  
E97 .N343
- [Indians in school; a study of the...](#)  
Officer, James E.  
E97 .032
- [Native enough](#)  
O'Leary, Nina  
E97 .044 2019
- [The tribally controlled Indian co...](#)  
Oppelt, Norman T.  
E97 .067 1990

## Native enough

[Request This](#)

Author	O'Leary, Nina, author, photographer.
Title	Native enough / Nina O'Leary.
Format	 Book
Published	East Lansing, Michigan : Makwa Enewed : Michigan State University Press, [2019] ©2019
Description	xiii, 130 pages : black and white portraits ; 21 x 31 cm.
Uniform series	<a href="#">Makwa Enewed series.</a>
Summary	"The project can be concisely explained as a representation of an experiential and phenotypic spectrum of the Native college student, and exists as a collection of portraits paired with excerpts from interviews done with the students immediately before taking their portraits. My goal was to illustrate to Natives and non-Natives that there is not just one way to think or look Native. To me, the portraits and interviews combined are experiential portraits."--Introduction.
Subject headings	Indians of North America--Portraits. Indian college students--United States--Pictorial works. Indians of North America--Pictorial works. Indian college students--United States--Ethnic identity. Indians of North America--Ethnic identity.
Genre heading	Photographs. Pictorial works. Portraits. Portraits.
ISBN	1938065050 (paperback) 9781938065057 (paperback)

## Holdings

Library	Blmgtn - Herman B Wells Library
Call Number	E97 .044 2019
Location	Material on Hold for a Borrower <a href="#">text this call number</a>



Tools

Add to folder

Cite ▾

Export to Refworks

Export to EndNote

Email

Librarian View

Browse by call number

Pratt, the red man's  
Eastman, Elaine Go  
E97.P9 E13

The Quest for quality  
E97 .Q38

Reclaiming indigenous  
research in higher  
education  
Minthorn, Robin Starr,  
Shotton, Heather J., 1976-  
xii, 228 pages ; 24 cm

## Reclaiming indigenous research in higher education

[Request This](#)

Title Reclaiming indigenous research in higher education / edited by Robin Starr Minthorn and Heather J. Shotton ; foreword by Bryan McKinley Jones Brayboy.

Format Book

Published New Brunswick, New Jersey : Rutgers University Press, [2018]

Description xii, 228 pages ; 24 cm

Other contributors Minthorn, Robin Starr, editor.  
Shotton, Heather J., 1976- editor.

Notes Includes bibliographical references and index.

Contents

- The need for indigenizing research in higher education scholarship / Charlotte Davidson, Heather J. Shotton, Robin Minthorn, and Stephanie Waterman
- "It was a process of decolonization and that's about as clear as I can put it" : Kuleana-centered higher education and the meanings of Hawaiianess / Erin Kahunawai Wright
- A methodology of beauty / Charlotte Davidson
- Understanding relationships in the college process : indigenous methodologies, reciprocity, and college horizon students / Adrienne Keene
- Story rug : weaving stories into research / Amanda Tachine
- Stealing horses : indigenous student metaphors for success in graduate education / Sweeney Windchief

## Holdings

Library Blmgtn - Herman B Wells Library

Call Number E97 .R43 2018

Location Wells Library - Research Coll. - Stacks

[text this call number](#)



Tools

Add to folder

Cite ▾

Export to Refworks

Export to EndNote

Email

Librarian View

Browse by call number:

American Indians and education; selected a...  
Bass, Willard P.  
E97 .B287

Education for action; selected a...  
E97 .B3

## Beyond access : indigenizing programs for Native American student success

[Request This](#)

Title Beyond access : indigenizing programs for Native American student success / edited by Stephanie J. Waterman, Shelly C. Lowe, and Heather J. Shotton ; foreword by George S. McClellan.

Format Book

Edition First edition.

Published Sterling, Virginia : Stylus Publishing, LLC., [2018]

Description xiii, 179 pages ; 23 cm

Other contributors Waterman, Stephanie J., 1957- editor.  
Lowe, Shelly C., editor.  
Shotton, Heather J., 1976- editor.

Portion of title Indigenizing programs for Native American student success

Notes Includes bibliographical references and index.

Summary "This book argues that two principal factors are inhibiting Native students from transitioning from school to college and from succeeding in their post-secondary studies. It presents models and examples of pathways to success that align with Native American students' aspirations and cultural values. Many attend schools that are poorly resourced where they are often discouraged from aspiring to college. Many are alienated from the educational system by a lack of culturally appropriate and meaningful environment or support systems that reflect Indigenous values of community, sharing, honoring extended family, giving-back to one's community, and respect for creation. The

## Holdings

Subject he

Library Blmgtn - Herman B Wells Library  
Call Number E97 .B48 2018  
Location Wells Library - Research Coll. - Stacks  
[text this call number](#)

# IR and privacy

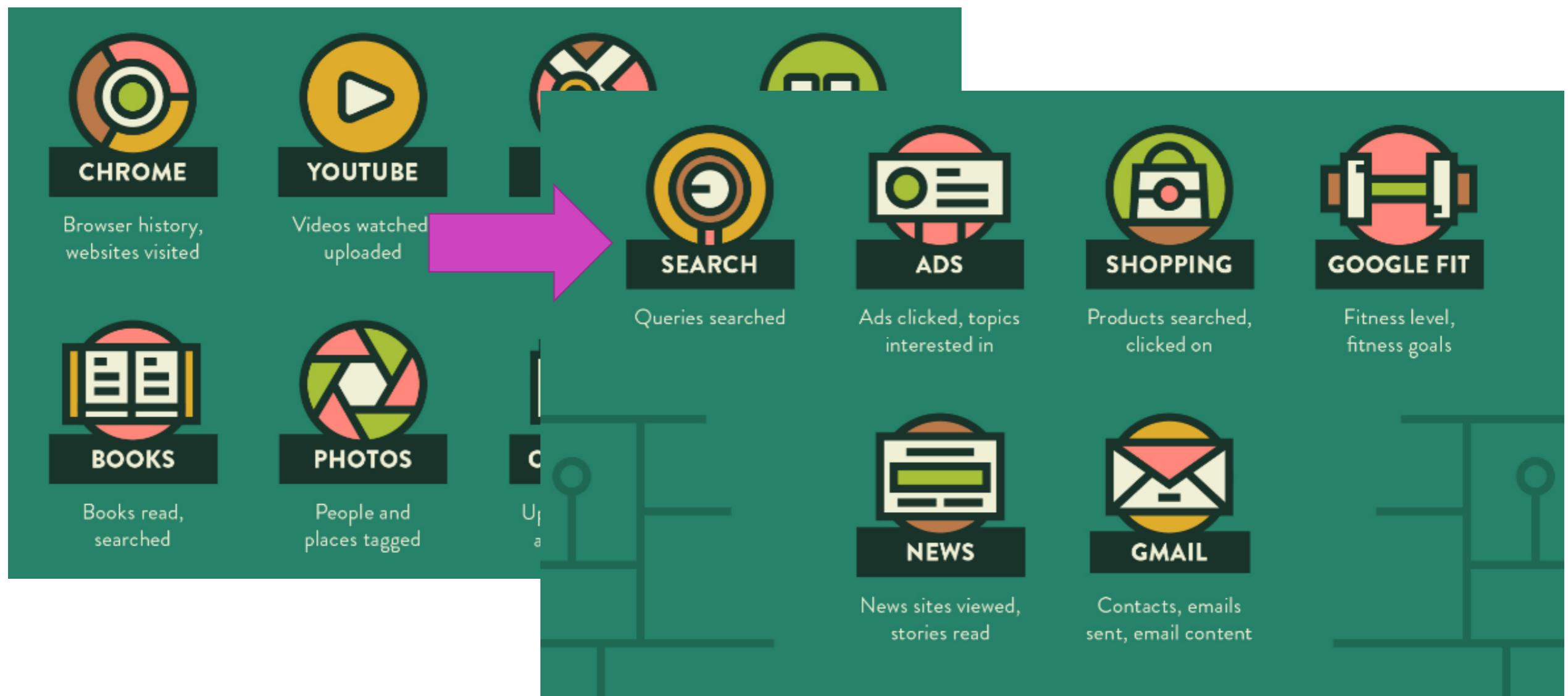


@StoryOfMy...Life



*"It's this new app—you put in your social security number,  
and it makes you look like a cat."*

# What does Google know?



# What does Google know?



# What does Google know?

**EVERYWHERE YOU'VE EVER BEEN**

*Google location monitoring and tracking apps keep detailed data on where you've been, when you were there and what you were doing.*

WHERE YOU LIVE      WHERE YOU WORK

WHERE YOU VISIT      WHERE YOU'VE TRAVELED

**HOW THIS INFORMATION IS COLLECTED**

CHROME      SEARCH      MAPS

CALENDAR      WAZE

# What does Google know?

**WHO YOUR FRIENDS ARE**

Gmail and Google Hangouts keep data on your contacts and conversations, while Google Maps and Google Calendar show where you've been and with who.

**WHO YOU TALK TO**

**WHO YOU EMAIL**

**WHERE YOU MEET THEM**

**WHAT YOU TALK ABOUT**

**HOW THIS INFORMATION IS COLLECTED**

The image shows five circular icons representing different Google services, each with a unique color and symbol:

- GMAIL**: A white envelope icon inside a yellow circle.
- MAPS**: A red location pin icon inside a pink circle.
- HANGOUTS**: A green speech bubble icon with two people inside, inside a green circle.
- CALENDAR**: A white icon showing two overlapping circles (one pink, one brown) inside a green circle.
- WAZE**: A yellow smiley face icon inside a yellow circle.

# What does Google know?

**WHAT YOU LIKE AND DISLIKE**

*Google assess what you're interested in from the queries you search, ads you click on and apps you use.*

FOOD      BOOKS

MOVIES      VIDEOS

STORES

**HOW THIS INFORMATION IS COLLECTED**

CHROME      SEARCH      NEWS

BOOKS      SHOPPING      YOUTUBE

# What does Google know?

**YOUR FUTURE PLANS**

*Google Calendar and Gmail track your upcoming trips, reservations and appointments, while your search queries tell a story about what you want for the future.*

WHAT YOU'RE THINKING ABOUT BUYING

UPCOMING TRIPS

WHERE YOU WANT TO TRAVEL

IF YOU WANT TO HAVE CHILDREN

**HOW THIS INFORMATION IS COLLECTED**

CHROME      SEARCH

CALENDAR      GMAIL

# What does Google know?

**YOUR ONLINE LIFE**

*Google saves all your online history, from what sites you visit to how many bookmarks you have.*

The infographic is a grid of seven colored boxes arranged in two columns and three rows. The top row contains 'EVERY WEBSITE YOU'VE EVER VISITED' (teal) and 'YOUR CHROME STORE APPS' (pink). The middle row contains 'YOUR CHROME STORE EXTENSIONS' (light green) and 'YOUR BROWSER SETTING' (orange). The bottom row contains 'YOUR DATA THAT AUTOFILLS' (teal), 'YOUR OPEN TABS' (yellow), and 'YOUR BOOKMARKED PAGES' (teal). Below the grid, the text 'HOW THIS INFORMATION IS COLLECTED' is centered, followed by three circular icons: a multi-colored target, a stylized letter 'G', and an envelope.

EVERY WEBSITE YOU'VE EVER VISITED	YOUR CHROME STORE APPS
YOUR CHROME STORE EXTENSIONS	YOUR BROWSER SETTING
YOUR DATA THAT AUTOFILLS	YOUR OPEN TABS
YOUR BOOKMARKED PAGES	

**HOW THIS INFORMATION IS COLLECTED**

# Clicks

- “If Google wants to know **how to get more people to click** on ads on their sites, they may try two shades of blue in ads - one shade for group A, another for Group B. Google can then compare click rates.” - Everybody Lies, [Seth Stephens-Davidowitz](#)

# Clicks



- Which combination got the most clicks? Why?
- Borrowed from Everybody Lies, [Seth Stephens-Davidowitz](#)

# Clicks



- The winner? The Obama family + the “Learn More” button, by an estimated 40% more sign ups, roughly \$60 million in funding.
- - Everybody Lies, [Seth Stephens-Davidowitz](#)

# Headlines (Boston Globe)

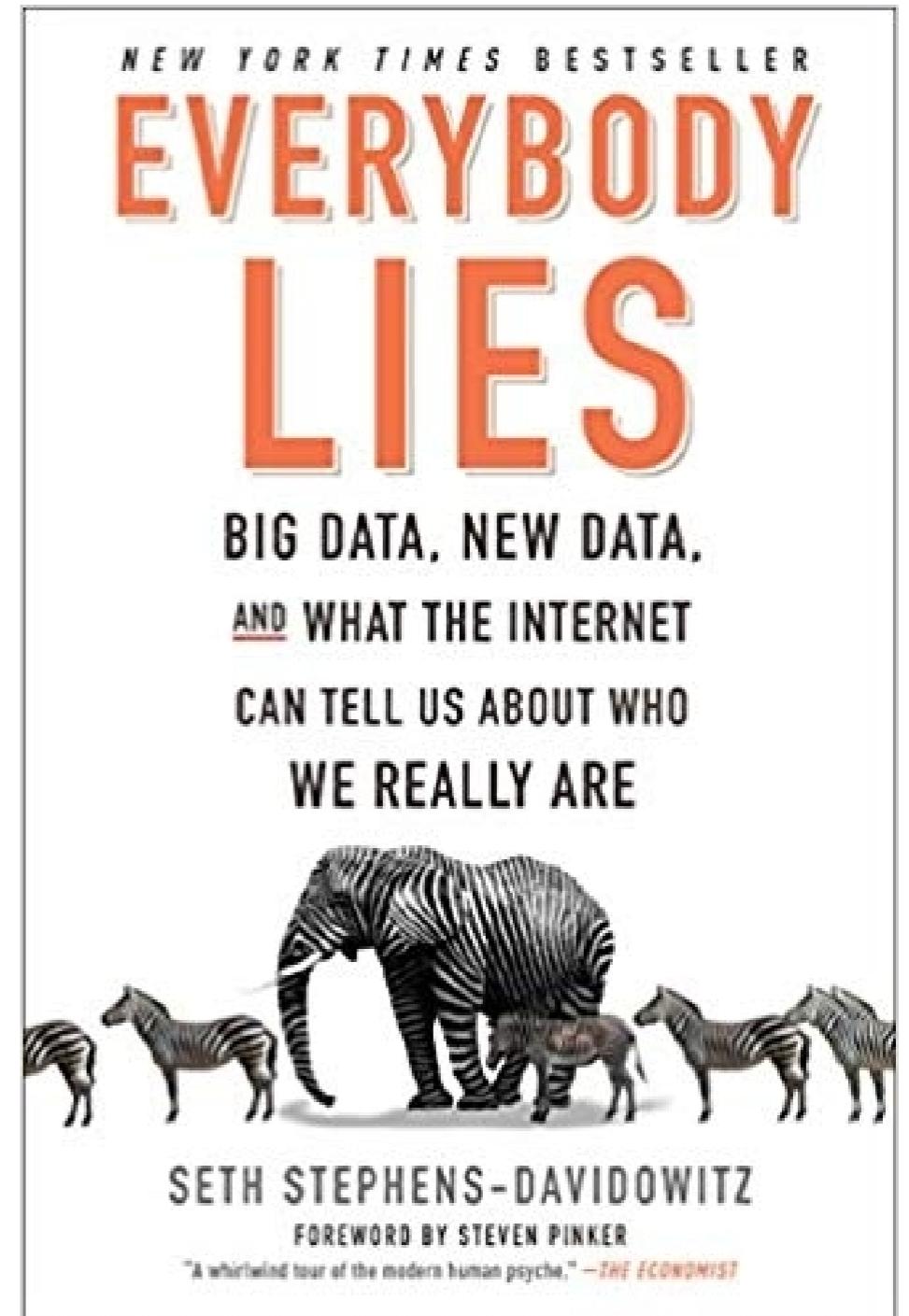
- Which do you think got the most clicks? Why?
- What does this tell us about human nature?
- Does it bother you to think that news organizations are testing ways to get you to click?
- - Everybody Lies, [Seth Stephens-Davidowitz](#)

Headline A	Headline B
Can the SnotBot drone save the whales?	Can this drone help save the whales?
Of course “deflated balls” is a top search term in Massachusetts	This top Mass. Google search term is pretty embarrassing
Hookup contest at heart of St. Paul rape trial	No charges in prep school sex scandal
Woman makes bank off rare baseball card	Woman makes \$179,000 off rare baseball card
MBTA projects annual operating deficit will double by 2020	Get ready: the MBTA’s deficit is about to double
How Massachusetts helped win you the right to birth control access	How Boston University helped end “crimes against chastity”
When the first subway opened in Boston	Cartoons from when the first subway opened in Boston
Victim and family in prep-school rape trial blame toxic culture	Victim and family in prep-school rape trial release statement
Guy in “Free Brady” hat is only one able to foil Miley Cyrus prank	Pats fan gets an eyeful for recognizing an undercover Miley Cyrus

# Headlines

Headline A	Headline B	
Can the SnotBot drone save the whales?	Can this drone help save the whales?	53% more clicks
Of course “deflated balls” is a top search term in Massachusetts	This top Mass. Google search term is pretty embarrassing	986% more clicks
Hookup contest at heart of St. Paul rape trial	No charges in prep school sex scandal	108% more clicks
Woman makes bank off rare baseball card	Woman makes \$179,000 off rare baseball card	38% more clicks
MBTA projects annual operating deficit will double by 2020	Get ready: the MBTA’s deficit is about to double	62% more clicks
How Massachusetts helped win you the right to birth control access	How Boston University helped end “crimes against chastity”	188% more clicks
When the first subway opened in Boston	Cartoons from when the first subway opened in Boston	33% more clicks
Victim and family in prep-school rape trial blame toxic culture	Victim and family in prep-school rape trial release statement	76% more clicks
Guy in “Free Brady” hat is only one able to foil Miley Cyrus prank	Pats fan gets an eyeful for recognizing an undercover Miley Cyrus	67% more clicks

“Facebook now runs a thousand A/B tests per day, which means that a small number of engineers at Facebook start more randomized, controlled experiments *in a given day than the entire pharmaceutical industry starts in a year.*” - Everybody Lies, [Seth Stephens-Davidowitz](#)



# Algorithms

- “To give you the most useful information, Search algorithms look at many factors, including the words of your query, relevance and usability of pages, expertise of sources, and your location and settings. The weight applied to each factor varies depending on the nature of your query—for example, the freshness of the content plays a bigger role in answering queries about current news topics than it does about dictionary definitions.” – From [Google](#)
- Factors considered by Google:
  - Meaning of your query
  - Relevance of webpages
  - Quality of the content
  - Usability of webpages
  - Context and settings

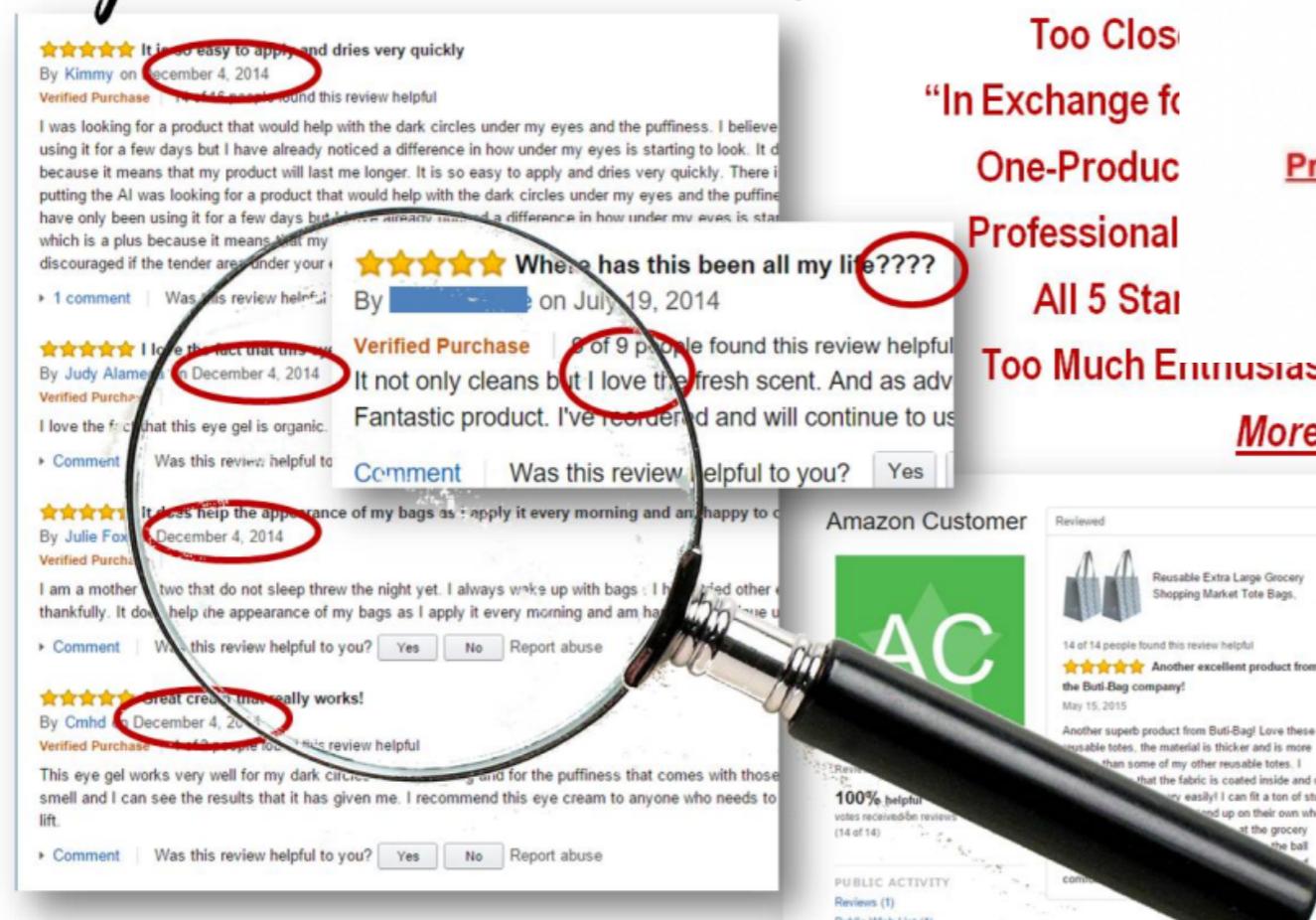
# IR and “the truth”

# Consider:

- Misinformation
- Information that's contested (epistemological disagreements)
- Information that's biased or bigoted
- Information that's targeted
- Value systems underlying these judgments

# Fraud [

## Spot a FAKE Review



<https://www.businessinsider.com/the-dumbest-things-bill-gates-ever-said-2016-4>

# INFOWARS

THE TRUTH ABOUT THE CRISIS ACTOR HOAX AT PARKLAND HIGH

MUST go viral! Infowars YouTube to be deleted based on this fraud!

Words associated with fake news outlets

IS A NUKE FALSE FLAG BEING PREPARED FOR USA?

MSM hinting at possible attack

HILLARY CLINTON: DEMONIC WARMONGER

WWIII has a higher chance of occurring with Clinton in The White House

Predicted fake-news ranking:



InfoWars is a far-right American conspiracy theories and fake news website and media platform owned by Alex Jones's Free Speech Systems LLC.<sup>[14]</sup> It was founded in 1999.





covid vaccine has microchip bill gates



All

News

Images

Shopping

Videos

More

Tools

About 199,000 results (0.55 seconds)

<https://www.theverge.com> › covid-vaccine-microchip-c... ::

## Where did the microchip vaccine conspiracy theory come from ...

Jun 5, 2021 — On October 2nd, 2020, then-President Donald Trump and the first lady tested positive for the **coronavirus**. As we were all waking up to the ...

<https://www.cnbc.com> › 2021/10/01 › why-the-covid-v... ::

## Why the Covid vaccines don't contain a magnetic 5G tracking ...

Oct 1, 2021 — Doctors and scientists explain why the **Covid vaccines** can't contain tracking **microchips** that make the spot magnetic, despite viral TikToks ...

<https://www.cnbc.com> › video › 2021/10/01 › why-the... ::

## Why there's no 5G tracking microchip in the Covid vaccines

Oct 1, 2021 — Among the conspiracy theories circulating about the **coronavirus** pandemic, one claim is that **Covid-19 vaccines** contain **microchips** that the ...

<https://www.france24.com> › ... › Shows › Fact or Fake ::

## Covid-19 vaccine: Is Bill Gates implanting us with 5G ...

Jul 19, 2021 — One issue causing real concern about public health is fake news around **Covid-19 vaccines**. In France, anti-vaccine sentiment is already high, ...

<https://www.theverge.com> › covid-vaccine-microchip-c... ::

## Where did the microchip vaccine conspiracy theory come from ...

Jun 5, 2021 — On October 2nd, 2020, then-President Donald Trump and the first lady tested positive for the **coronavirus**. As we were all waking up to the ...

<https://www.cnbc.com> › 2021/10/01 › why-the-covid-v... ::

## Why the Covid vaccines don't contain a magnetic 5G tracking ...

Oct 1, 2021 — Doctors and scientists explain why the **Covid vaccines** can't contain tracking **microchips** that make the spot magnetic, despite viral TikToks ...

<https://www.cnbc.com> › video › 2021/10/01 › why-the... ::

## Why there's no 5G tracking microchip in the Covid vaccines

Oct 1, 2021 — Among the conspiracy theories circulating about the **coronavirus** pandemic, one claim is that **Covid-19 vaccines** contain **microchips** that the ...

<https://www.france24.com> › ... › Shows › Fact or Fake ::

## Covid-19 vaccine: Is Bill Gates implanting us with 5G ...

Jul 19, 2021 — One issue causing real concern about public health is fake news around **Covid-19 vaccines**. In France, anti-**vaccine** sentiment is already high, ...

<https://www.youtube.com> › watch ::

## Why It's Impossible To Put Tracking Microchips In Covid ...

Sep 29, 2021 — Among the conspiracy theories circulating about the pandemic, one claim is that **Covid-19 vaccines** contain **microchips** that the government or ...

<https://www.bbc.com> › news ::

## Coronavirus: Bill Gates 'microchip' conspiracy theory ... - BBC

May 30, 2020 — Fact-checking **vaccine** claims - including ones about the ex-Microsoft boss and a dubious cow-dung trial.

<https://www.reuters.com> › article › fact-check-rfid-micr... ::

RFID microchips will not be injected with the COVID-19 vaccine

## About this result

BETA



### Source

 France 24 is a French state-owned international news television network based in Paris. Its channels broadcast in French, English, Arabic, and Spanish and are aimed at the overseas market. Based in the Paris suburb of Issy-les-Moulineaux, the service started on 6 December 2006. [Wikipedia](#)

- Your connection to this site is **secure**
- <https://www.france24.com/en/tv-shows/fact-or-fake/20210719-covid-19-vaccine-is-bill-gates-implanting-us-with-5g-microchips>

[More about this page](#) >

### Your search & this result

- These search terms appear in the result: **covid**, **vaccine**, **has**, **bill**, and **gates**
- Terms related to your search appear in the result: **vaccines** and **microchips**
- Other websites with your search terms link to this result
- The result is in **English**
- This result seems relevant for searches from many regions, including the **United States**

[Learn more search tips](#) >

This is a search result, not an ad. Only ads are paid, and they'll always be labeled with "Sponsored" or "Ad."

 Privacy settings

 How Search works

Cached

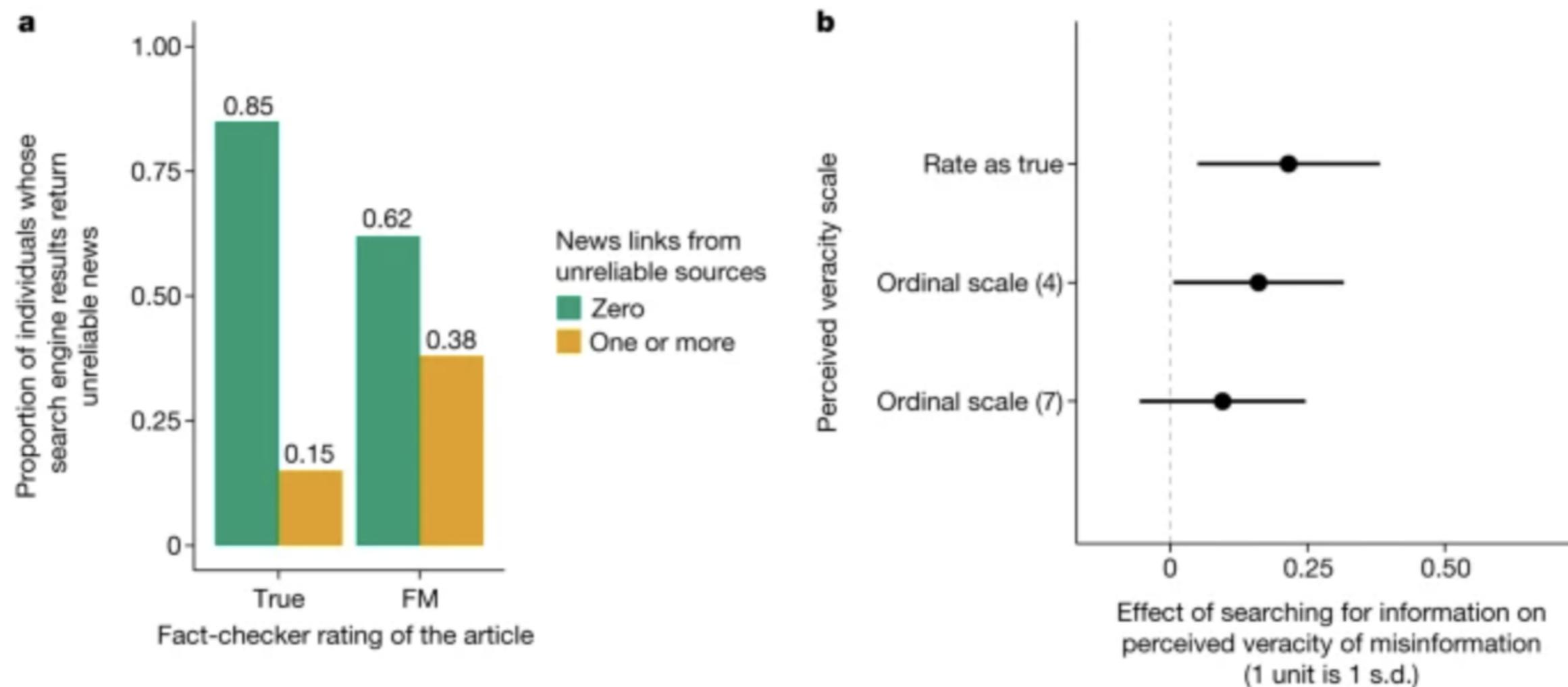
## Online searches to evaluate misinformation can increase its perceived veracity

[Kevin Aslett](#) , [Zeve Sanderson](#), [William Godel](#), [Nathaniel Persily](#), [Jonathan Nagler](#) & [Joshua A. Tucker](#)

[Nature](#) **625**, 548–556 (2024) | [Cite this article](#)

81k Accesses | 65 Citations | 1816 Altmetric | [Metrics](#)

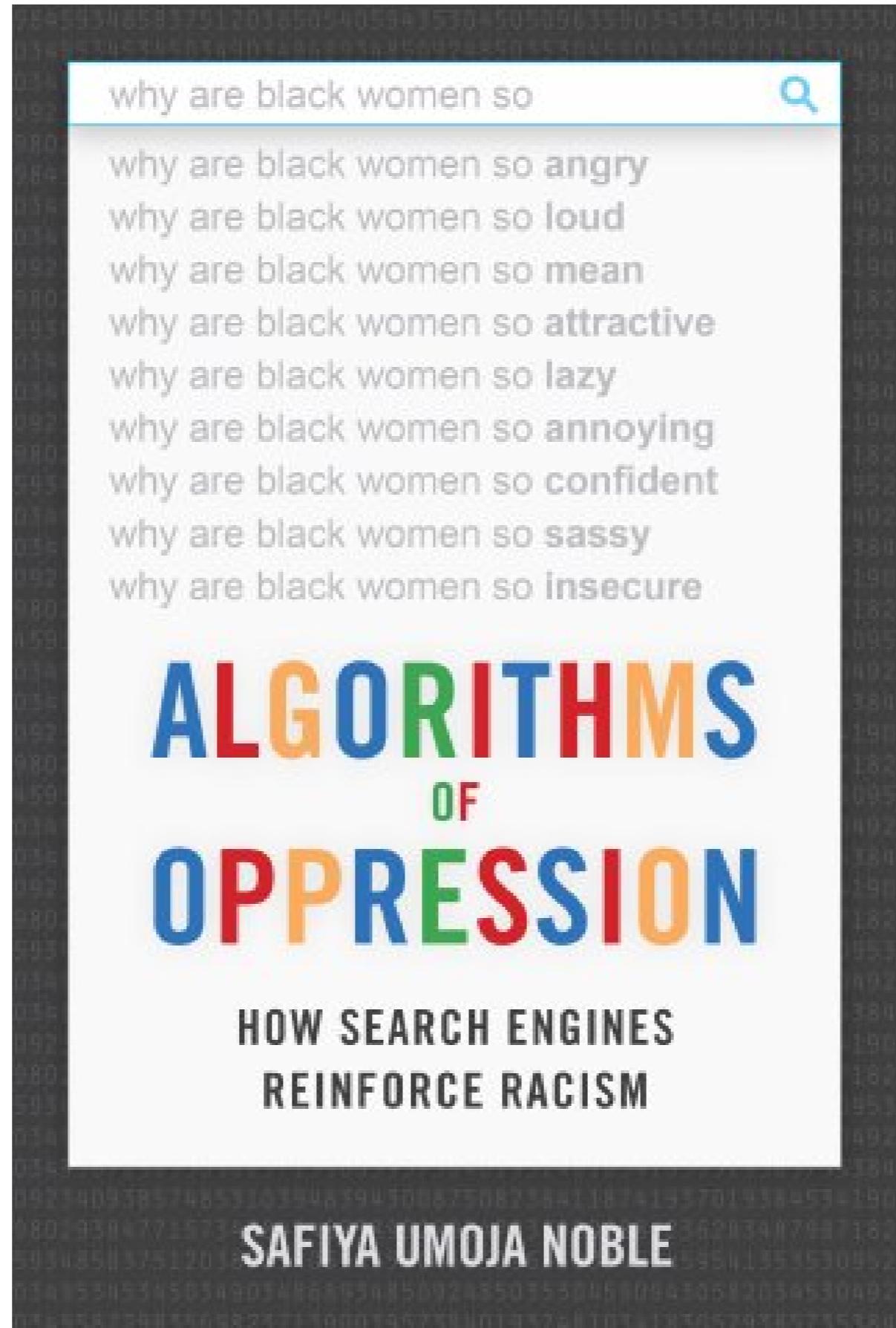
**Fig. 2: How Google search results impact belief in misinformation (study 5).**



# Many challenges

- **How to verify information snippets?**
  - Open-domain fact checking is hard!
- **How to inform users about trust in results?**
  - Will they pay attention / care?
- **Which content should you index?**
  - How might scammers work around this?
- **What role should a tech company play in arbitrating truth?**
  - Transparency?
  - Is it their job?
  - Is the search engine everyone's "authority"?

# IR and fairness



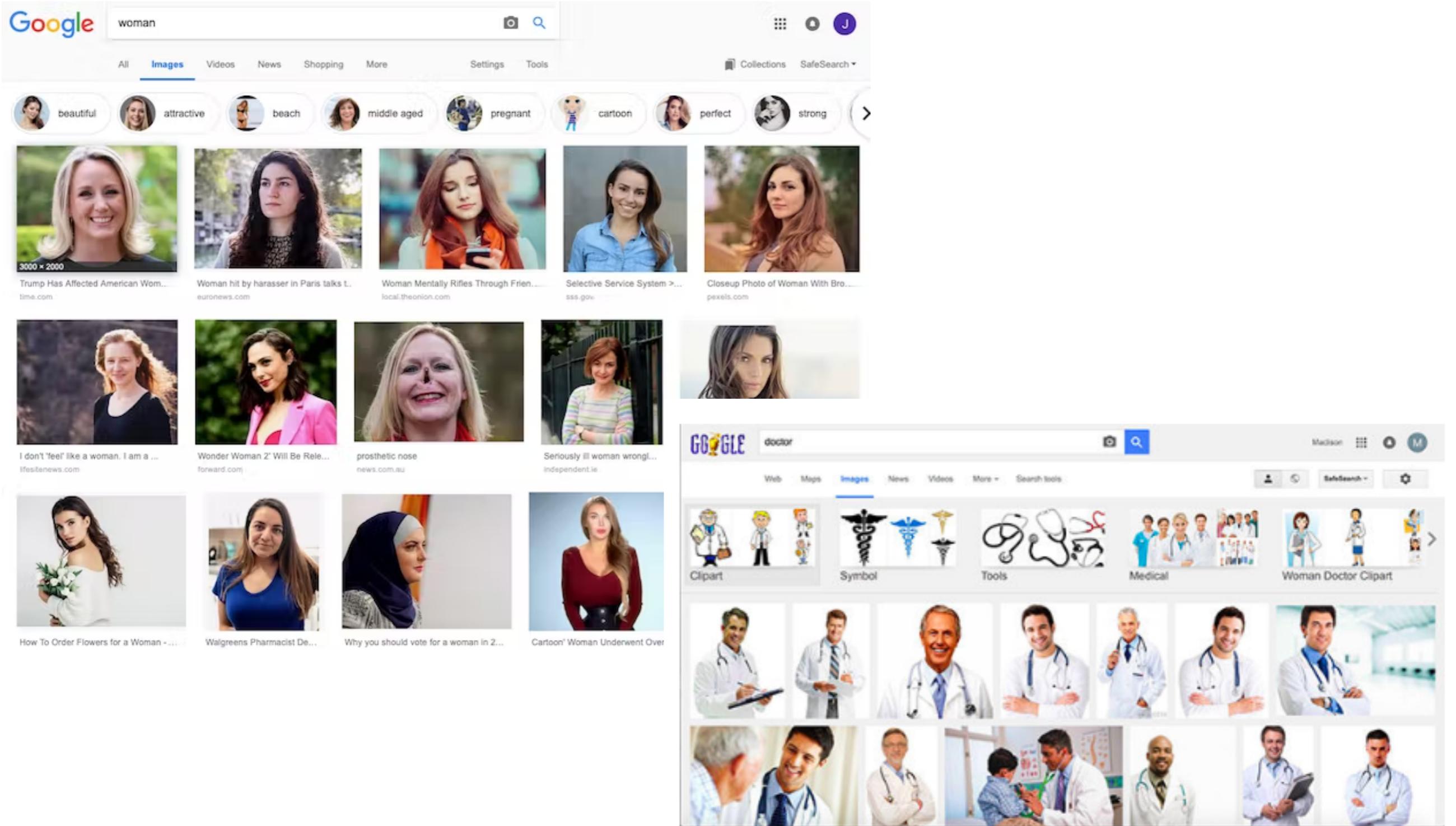


Figure 2.14. Google Images search on “doctor” featuring men, mostly White, as the dominant representation, April 7, 2016.

Google Scholar justice

Articles About 1,740,000 results (0.03 sec)

**[PDF] Foreword: justice engendered**

M Minow - Harv. L. Rev., 1987 - HeinOnline

3 Note how this phrase is both an insistent inquiry into difference and a casual shrug about why a difference does not matter. In an episode of the television show, "All in the Family," ...

☆ Save 99 Cite Cited by 1269 Related articles All 2 versions ☺

**What Justice is About**

T Campbell - Justice, 1988 - Springer

... Arguments about **justice** and injustice feature centrally in current ... of **justice** which emerge in argument about such contentious political issues that this book is concerned. What is **justice**? ...

☆ Save 99 Cite Cited by 360 Related articles All 4 versions ☺

**Sociological justice**

D Black - 1993 - philpapers.org

That discrimination exists in courts of law is beyond dispute. In American murder cases, for instance, studies show that blacks who kill a white are much more likely to receive the death ...

☆ Save 99 Cite Cited by 661 Related articles All 3 versions ☺

**[PDF] Foreword: The forms of justice**

OM Fiss - Harv. L. Rev., 1979 - HeinOnline

The Constitution establishes the structure of government. It creates the agencies of government, describes their functions, and determines their relationships. The Constitution also ...

☆ Save 99 Cite Cited by 2173 Related articles All 3 versions ☺

Google Scholar islamic justice

Articles About 1,570,000 results (0.09 sec)

**[book] The Islamic conception of justice**

M Khadduri - 1984 - books.google.com

... It is the purpose of this work to study the experiences of **Islam** with **justice** and how its leaders and thinkers grappled with the problem of how the standard of **justice** is to be defined and ...

☆ Save 99 Cite Cited by 611 Related articles All 3 versions ☺

**[book] The anthropology of justice: Law as culture in Islamic society**

L Rosen - 1989 - books.google.com

... It is used to examine **Islamic** law. By considering particular ... obscure points with regard to **Islamic** law and procedure. He is ... broaden our understanding not only of **Islamic** law, but of law ...

☆ Save 99 Cite Cited by 607 Related articles All 3 versions ☺

**On the notion of economic justice in contemporary Islamic thought**

T Kuran - International Journal of Middle East Studies, 1989 - cambridge.org

... **justice** that appears in this body of literature. I begin by defining the main principles of **justice** to which the **Islamic** ... room for interpretation than the **Islamic** economists acknowledge. In ...

☆ Save 99 Cite Cited by 131 Related articles All 8 versions ☺

**[book] The justice of Islam: comparative perspectives on Islamic law and society**

L Rosen - 2000 - books.google.com

... The ways in which Muslims articulate their sense of **justice** and injustice over time is especially important here. The argument is put forth that **justice** in **Islamic** cultures does not mean ...

☆ Save 99 Cite Cited by 283 Related articles All 2 versions ☺

Google Scholar sustainability

Articles About 4,390,000 results (0.04 sec)

**[HTML] The sustainability debate**

A Wilkinson, M Hill, P Gollan - International Journal of Operations & ..., 2001 - emerald.com

... on the topic of **sustainability**. It commences with definitions of **sustainability**, followed by a ... The paper then goes on to discuss the company capacities required to achieve **sustainability**...

☆ Save 99 Cite Cited by 590 Related articles All 9 versions ☺

**Sustainability**

I Scoones - Development in practice, 2007 - Taylor & Francis

... ) **sustainability**. And within economics, debates raged over whether such a 'weak' definition of **sustainability** ... bottom line' emerged, in which **sustainability** was seen as one among other ...

☆ Save 99 Cite Cited by 334 Related articles All 8 versions ☺

**[BOOK] Sustainability**

KE Portney - 2015 - books.google.com

... **sustainability** in a range of contemporary contexts, from economic development to government policy. The word "sustainability" ... the term, the concept of **sustainability** has come to mean a ...

☆ Save 99 Cite Cited by 233 Related articles All 4 versions ☺

**The concept of environmental sustainability**

R Goodland - Annual review of ecology and systematics, 1995 - JSTOR

... **sustainability**, then focuses on environmental **sustainability** (... action required to approach global **sustainability** in real life. ... of **sustainability**, perhaps in the future, a general **sustainability** ...

☆ Save 99 Cite Cited by 2308 Related articles All 23 versions ☺

Google Scholar indigenous sustainability

Articles About 2,110,000 results (0.13 sec)

**[PDF] The indigenous sustainability paradox and the quest for sustainability in post-colonial societies: Is indigenous knowledge all that is needed**

B Maragia - Geo. Int'l Envtl. L. Rev., 2005 - HeinOnline

... of definitions 3 and principles4 of **sustainable** development, reflecting different visions of ... of **sustainable** development in international environmental law. 6 **Sustainable** development has ...

☆ Save 99 Cite Cited by 52 Related articles All 2 versions ☺

**[HTML] Weaving Indigenous and sustainability sciences to diversify our methods**

JT Johnson, R Howitt, G Cajete, F Berkes, RP Louis... - Sustainability ..., 2016 - Springer

... entitled Weaving **Indigenous** and **Sustainability** Sciences: ... presentations on **sustainability** science, **Indigenous** science, and ... regarding how **Indigenous** and **sustainability** sciences may ...

☆ Save 99 Cite Cited by 256 Related articles All 8 versions ☺

**[HTML] Indigenous environmental justice and sustainability**

D McGregor, S Whitaker, M Sritharan - ... in Environmental Sustainability, 2020 - Elsevier

... issue on **Indigenous** conceptualizations of 'sustainability' ... **Indigenous** peoples assert that a just path to a **sustainable** ... approach best expressed through **Indigenous** knowledge systems, ...

☆ Save 99 Cite Cited by 106 Related articles All 4 versions ☺

**[HTML] Indigenous sustainable relations: Considering land in language and language in land**

J Ferguson, M Weaselboy - Current Opinion in Environmental Sustainability, 2020 - Elsevier

... of **Indigenous** minority languages and lifeways, suggesting that projects concerning either the **sustainability** of ... Under a framework of 'sustainable' relations,' we explore how **Indigenous** ...

☆ Save 99 Cite Cited by 17 Related articles All 3 versions ☺

# Many challenges

- **How to verify information?**
  - What does it mean for search results to be “biased” or racist?
  - How do you audit?
- **How to inform users about trust/balance in results?**
  - What metrics and groups do users care about?
- **Which content should you show?**
  - e.g., what should be race breakdown of the top 20 hits for “doctor”? Taking into account intersectional identity?
- **What role should a tech company play in arbitrating truth?**
  - Who works at a tech company? Are they aware of all issues?
  - What is their goal in “fixing” these systems? What is truly a “fix”?

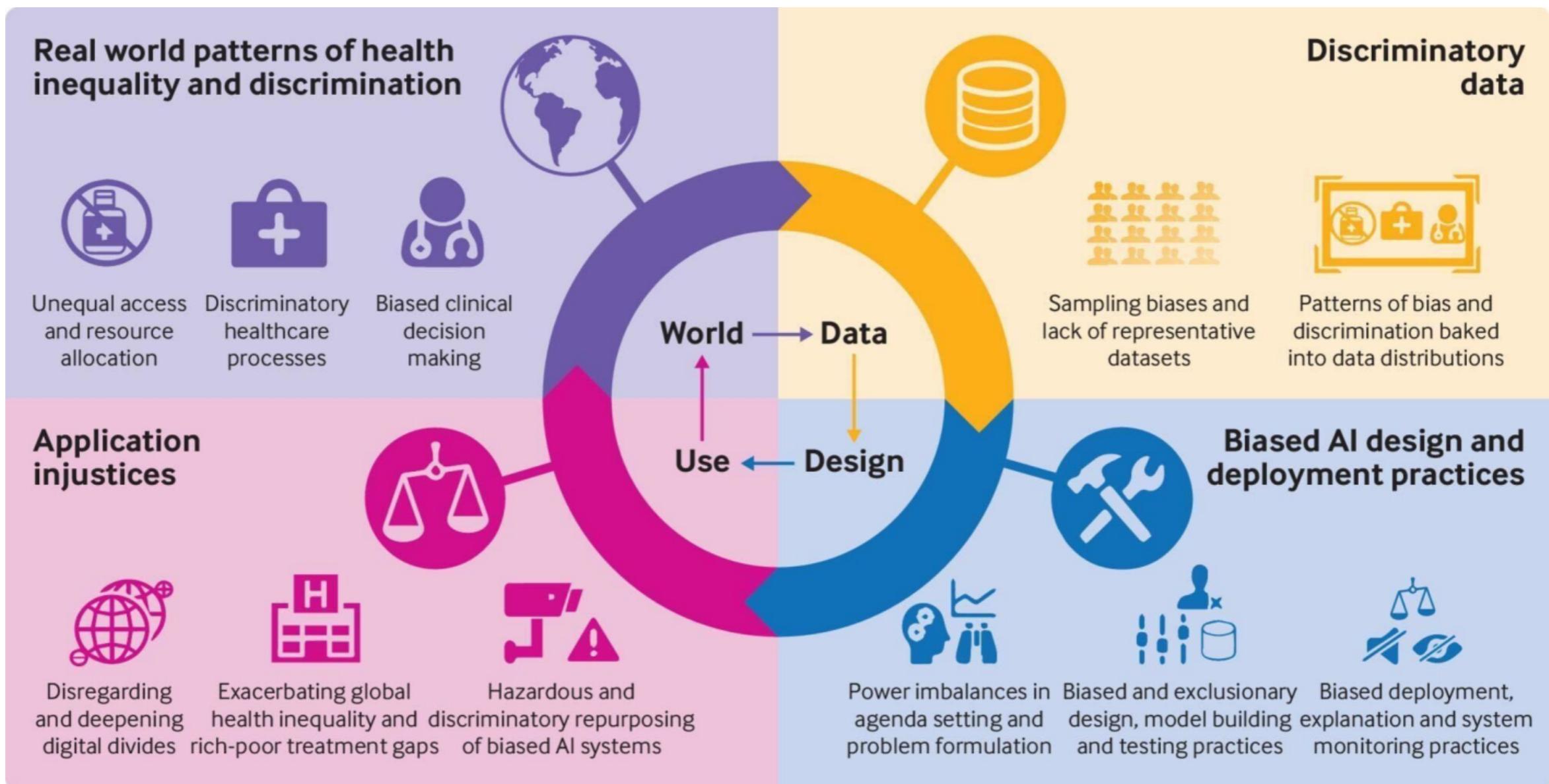
“Note these side effects weren’t by accident as they were actually programmed in the Google search engine which prefers the human bias of algorithms.”

- Safiya Noble

# Where do these issues come from?

Who is treated as the expert?  
Who has money to pay for slots?

What gets digitized? Indexed?  
Low resource languages?



Positive Feedback Loops:  
TF-IDF, PageRank, SEO

# One Attempt from 2008: Blackbird



**Table I.** Google search vs Blackbird search: 'Barack Obama' (conducted May 2009)

Google search	Blackbird search
<a href="http://www.barackobama.com">www.barackobama.com</a> <a href="http://En.wikipedia.org/wiki/Barack_Obama">En.wikipedia.org/wiki/Barack_Obama</a> <a href="http://www.whitehouse.gov/administration/President_Obama">www.whitehouse.gov/administration/President_Obama</a> <a href="http://www.myspace.com/barackobama">www.myspace.com/barackobama</a>	<a href="http://www.barackobama.com">www.barackobama.com</a> <a href="http://www.blackvoices.com/obama-watch">www.blackvoices.com/obama-watch</a> <a href="http://Blogs.blackvoices.com/category/barack-obama">Blogs.blackvoices.com/category/barack-obama</a>
<a href="http://www.barackobama.com/issues">www.barackobama.com/issues</a> <a href="http://www.chicagotribune.com/topic/politics/.../barack-obamaPEPLT007408.topic">www.chicagotribune.com/topic/politics/.../barack-obamaPEPLT007408.topic</a> <a href="http://www.youtube.com/barackobama">www.youtube.com/barackobama</a> <a href="http://www.reuters.com/news/globalcoverage/barackobama">www.reuters.com/news/globalcoverage/barackobama</a> <a href="http://www.barackobama.com/about">www.barackobama.com/about</a>	<a href="http://www.samefacts.com/2008/02/race-related-isms/is-barack-obama-black/">www.samefacts.com/2008/02/race-related-isms/is-barack-obama-black/</a> <a href="http://En.wikipedia.org/wiki/Barack_Obama">En.wikipedia.org/wiki/Barack_Obama</a> <a href="http://Blogs.bet.com/news/pamela/2008/.../the-first-black-president-barack-obama">Blogs.bet.com/news/pamela/2008/.../the-first-black-president-barack-obama</a>
<a href="http://My.barackobama.com">My.barackobama.com</a>	<a href="http://www.baystatebanner.com/natl21-2009-02-12">www.baystatebanner.com/natl21-2009-02-12</a> <a href="http://www.blackvoices.com/news/election/barack-obama-celebrity-endorsers">www.blackvoices.com/news/election/barack-obama-celebrity-endorsers</a> <a href="http://www.blackamericaweb.com/?q=articles/news/movin_america_news">www.blackamericaweb.com/?q=articles/news/movin_america_news</a> <a href="http://Blackenterprise.com/.../barack-20-barack-obamas-social-media-lessons-for-business/">Blackenterprise.com/.../barack-20-barack-obamas-social-media-lessons-for-business/</a>

Brock, André. "Beyond the pale: The Blackbird web browser's critical reception." *New Media & Society* 13.7 (2011).

# Many challenges

- **How to verify information?**
  - What upstream values and downstream consequences does showing information have?
  - Under what value systems is this justified?
- **How to inform users about trust in results?**
  - How to monitor these values and consequences?
  - Do different people care about different things?
- **Which content should you show?**
  - What values underlie the choices in ranking?
  - How does showing that content affect people?
- **What role should a tech company play in arbitrating truth?**
  - Should they be “correcting” the real world? How?
  - What ideologies are they using? Who approves this?

# Quantifying fairness is hard!

- Many ways to measure fairness in IR:
  - Parity in ranking between documents from different groups—ignores relevance though!
    - Extensions try to model the expected relevance/ranking
  - Comparing fairness for a single vs. multiple queries
  - Pairwise comparisons of documents from different groups—how do items from different groups compare?
- How to handle missing data

# Auditing IR Algorithms

# State of Play

- Data volume is increasing exponentially
- Intelligent systems are increasingly ubiquitous
- Level of sophistication is increasing rapidly
- Adoption in sensitive contexts is becoming pervasive
  - Hiring, banking, healthcare, law enforcement, government services, autonomous vehicles, smart cities, etc.

# Risks

- Various types of harms
  - Privacy violations via ubiquitous surveillance and sophisticated inference methods
  - Entrenched discrimination (e.g. sexism, racism, ageism, etc.)
  - Predatory commerce
  - Biased and manipulative information curation
- What is different this time?
  - Scale unlike anything in human history
  - Information asymmetry due to centralization of data
  - Lack of transparency and accountability

# Need for Regulation?



**Data:** what can be collected, by whom, for what purpose



**Capabilities:** facial recognition, deepfakes, inference of sensitive attributes



**Outcomes:** no discrimination; unbiased presentation of information

# Enforcement?

**Accountability requires transparency**

## 1. Public source code?

- Millions of lines of code can't be comprehended
- Behavior of machine learning is based on data not code

## 2. Public data?

- Serious privacy concerns

# A Third Option: Algorithm Audits

**Algorithm Auditing:** the application of scientific measurement techniques to understand:

- When an algorithmic system is present
- Data collection and sharing practices
- Behavior of the system



Google Search

I'm Feeling Lucky



Latanya Sweeney



Google Search

I'm Feeling Lucky



Latanya Sweeney



Ad · [www.instantcheckmate.com](http://www.instantcheckmate.com)

## Latanya Sweeney, Arrested?

1) Enter Name and State 2) Access Full Background

Checks instantly

Ad · [www.publicrecords.com](http://www.publicrecords.com)

## Latanya Sweeney

Public records for Latanya Sweeney. View now.

Google  

Ad · [www.instantcheckmate.com](http://www.instantcheckmate.com)

## Latanya Sweeney, Arrested?

1) Enter Name and State 2) Access Full Background  
Checks instantly

Ad · [www.publicrecords.com](http://www.publicrecords.com)

## Latanya Sweeney

Public records for Latanya Sweeney. View now.

Google  

Ad · [www.instantcheckmate.com](http://www.instantcheckmate.com)

## Located: Jill Schneider

Information found on Jill Schneider. Jill Schneider found in database

Ad · [www.intelius.com](http://www.intelius.com)

## We found Jill Schneider

Current Phone, Address, Age & More. Instant and Accurate Jill Schneider  
Reverse Lookup - Reverse Cell Phone Directory - Property Records

Latanya Sweeney, *Discrimination in online ad delivery*, (2013)

# THE TIMES OF INDIA

**Google profile gender** · female

**Sponsored** · [www.jobsinyourarea.co](http://www.jobsinyourarea.co)

[Jobs \(Hiring Now\)](#)

**Sponsored** · [www.westernpatoyotaservice.com](http://www.westernpatoyotaservice.com)

[4Runner Parts Service](#)

**Sponsored** · [www3.mc3.edu/Criminal+Justice](http://www3.mc3.edu/Criminal+Justice)

[Criminal Justice Program](#)

**Sponsored** · [goodwill.careerboutique.com](http://goodwill.careerboutique.com)

[Goodwill - Hiring](#)

Amit Datta, Michael Carl Tschantz, Anupam Datta, *Automated Experiments on Ad Privacy Settings - A Tale of Opacity, Choice, and Discrimination*, 2015

# THE TIMES OF INDIA

**Google profile gender** · female

**Sponsored** · [www.jobsinyourarea.co](http://www.jobsinyourarea.co)

[Jobs \(Hiring Now\)](#)

**Sponsored** · [www.westernpatoyotaservice.com](http://www.westernpatoyotaservice.com)

[4Runner Parts Service](#)

**Sponsored** · [www3.mc3.edu/Criminal+Justice](http://www3.mc3.edu/Criminal+Justice)

[Criminal Justice Program](#)

**Sponsored** · [goodwill.careerboutique.com](http://goodwill.careerboutique.com)

[Goodwill - Hiring](#)

# THE TIMES OF INDIA

**Google profile gender** · male

**Sponsored** · [careerchange.com](http://careerchange.com)

[\\$200+ Jobs - Execs Only](#)

**Sponsored** · [careerchange.com](http://careerchange.com)

[Find Next \\$200k+ Job](#)

**Sponsored** · [www.youthcounseling.degreetleap.com](http://www.youthcounseling.degreetleap.com)

[Become a Youth Counselor](#)

**Sponsored** · [www.tadrivers.com/OTRJobs](http://www.tadrivers.com/OTRJobs)

[CDL-A OTR Trucking Jobs](#)

Amit Datta, Michael Carl Tschantz, Anupam Datta, *Automated Experiments on Ad Privacy Settings - A Tale of Opacity, Choice, and Discrimination*, 2015

# **Dozens of Companies Are Using Facebook to Exclude Older Workers From Job Ads**

Among the companies we found doing it: Amazon, Verizon, UPS and Facebook itself. “It’s blatantly unlawful,” said one employment law expert.

by Julia Angwin, ProPublica, Noam Scheiber, The New York Times, and Ariana Tobin, ProPublica, Dec. 20, 2017, 5:45 p.m. EST

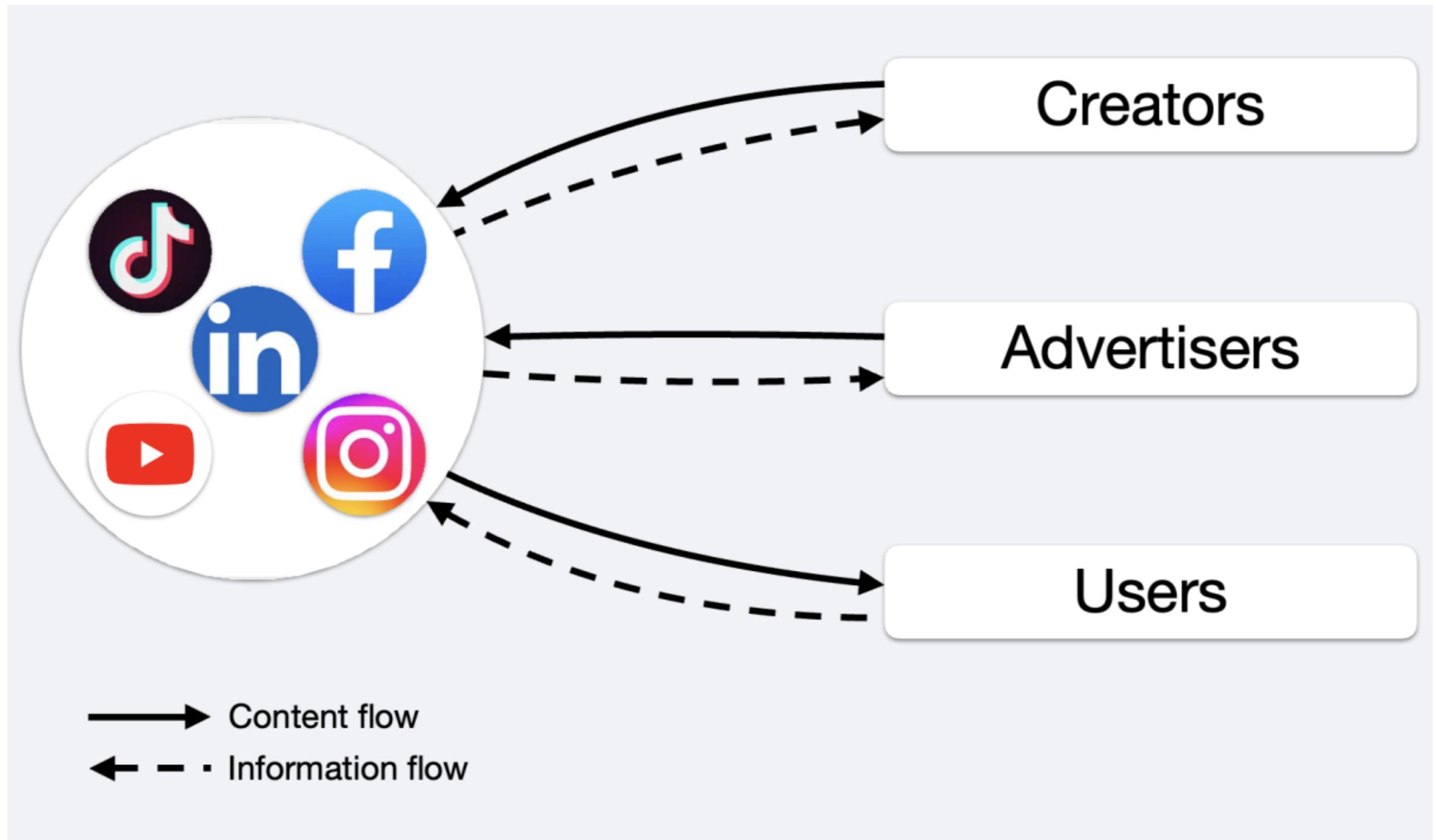
# **Facebook Lets Advertisers Exclude Users by Race**

Facebook’s system allows advertisers to exclude black, Hispanic, and other “ethnic affinities” from seeing ads.

by Julia Angwin and Terry Parris Jr., Oct. 28, 2016, 1 p.m. EDT



What is the search query in advertising? You!



Who has the most data here? And what kinds of audits can we run?

# Two Phases of Online Advertising

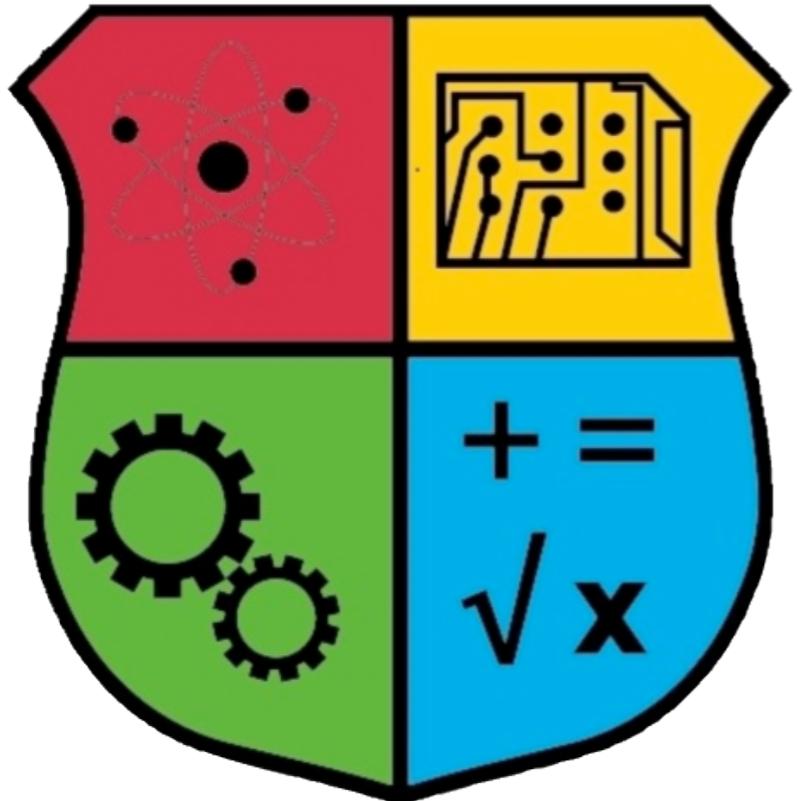
## Phase 1: targeting

- controlled by the advertiser
- who is the **target audience**

## Phase 2: ad delivery

- controlled by the platform
- who is the **actual audience**

- There can be bias in both



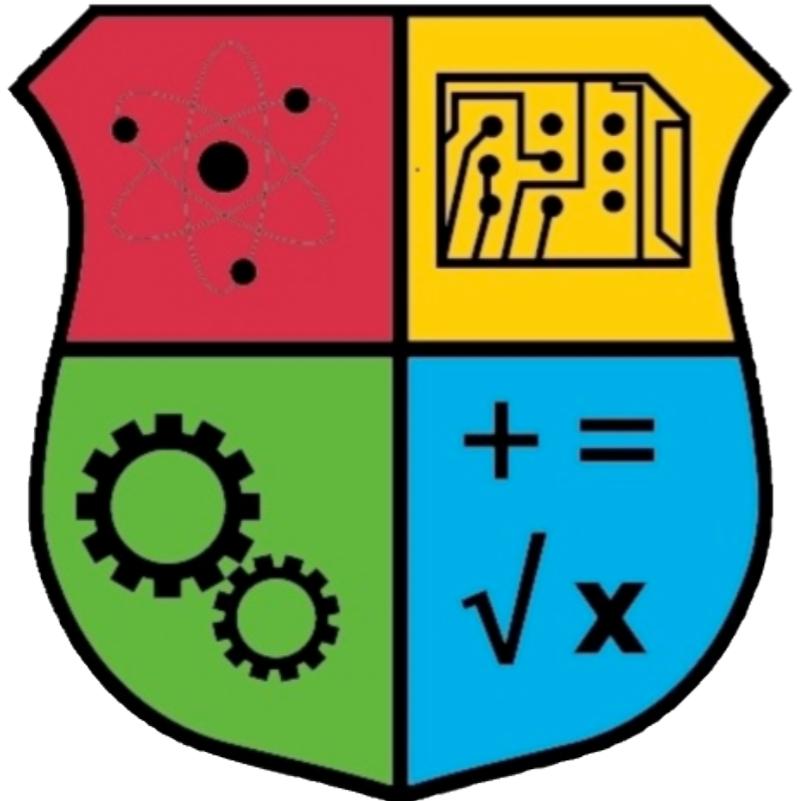
STEM Careers  
Information about STEM Careers

Like

Comment

Share

Anja Lambrecht, Catherine Tucker, *Algorithmic Bias? An Empirical Study of Apparent Gender-Based Discrimination in the Display of STEM Career Ads*, (2019)



STEM Careers  
Information about STEM Careers

Like

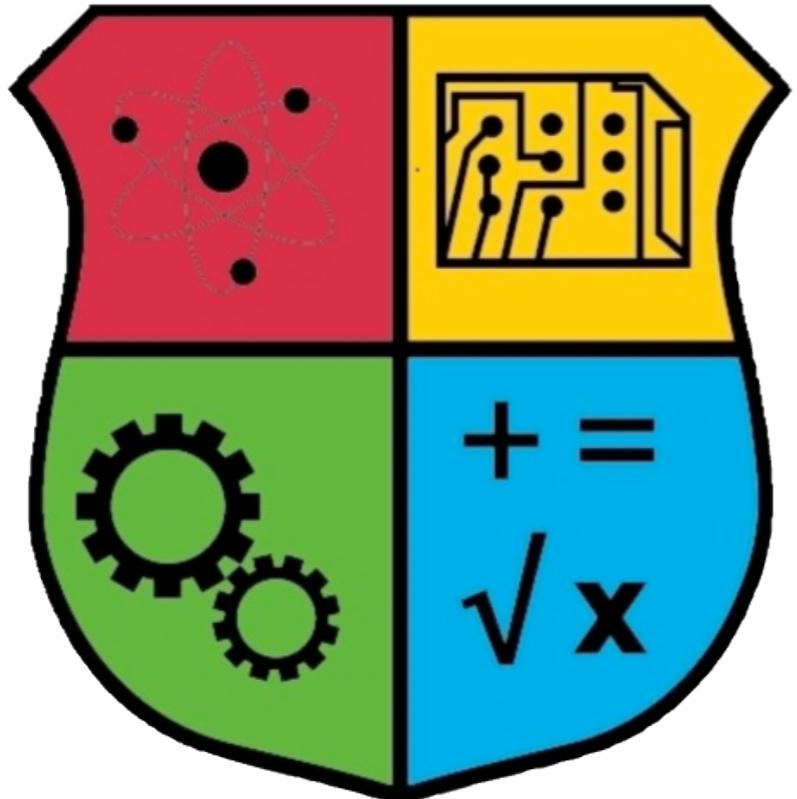
Comment

Share



US Facebook users

Anja Lambrecht, Catherine Tucker, *Algorithmic Bias? An Empirical Study of Apparent Gender-Based Discrimination in the Display of STEM Career Ads*, (2019)



STEM Careers  
Information about STEM Careers

Like

Comment

Share



US Facebook users



Users who were shown the ad

Anja Lambrecht, Catherine Tucker, *Algorithmic Bias? An Empirical Study of Apparent Gender-Based Discrimination in the Display of STEM Career Ads*, (2019)

What are some potential explanations?

Begin your career as a sanitation worker, a janitorial cleaner, or a housekeeper.



INDEED.COM

**Find a job in cleaning**

26,175 Janitor jobs available on indeed.com.

Like

Comment

Share

Begin your career working at a lumber yard, sawmill, construction, or even in the forest.



INDEED.COM

**Find a job in lumber industry**

10,417 Lumber jobs available on indeed.com.

Like

Comment

Share

A way to address the market forces: Instead of one ad, launch two!

Begin your career as a sanitation worker, a janitorial cleaner, or a housekeeper.



INDEED.COM

### Find a job in cleaning

26,175 Janitor jobs available on indeed.com.

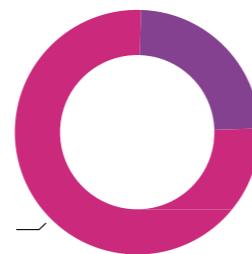
Like

Comment

Share



63% Black



76% women

Begin your career working at a lumber yard, sawmill, construction, or even in the forest.



INDEED.COM

### Find a job in lumber industry

10,417 Lumber jobs available on indeed.com.

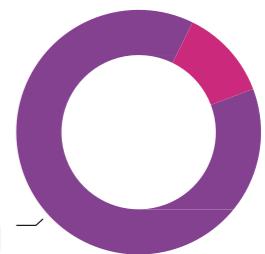
Like

Comment

Share



75% white



88% men

M. Ali\*, P. Sapiezynski\*, M. Bogen, A. Korolova, A. Mislove, and A. Rieke, *Discrimination through optimization: How Facebook's ad delivery can lead to biased outcomes*, (2019)

Become a driver at Domino's and deliver pizza.



[JOBS.DOMINOS.COM](https://JOBS.DOMINOS.COM)

**Domino's is now hiring  
pizza delivery drivers.**

[LEARN  
MORE](#)

Like

Comment

Share

Become a driver at Instacart and deliver groceries.



**instacart**

**GROCERY  
DELIVERY**

[SHOPPERS.INSTACART.COM](https://SHOPPERS.INSTACART.COM)

**Instacart is now hiring  
grocery delivery drivers.**

[LEARN  
MORE](#)

Like

Comment

Share

B. Imana, A. Korolova, and J. Heidemann, *Auditing for Discrimination in Algorithms Delivering Job Ads*, (2021)

Become a driver at Domino's and deliver pizza.



JOBSDOMINOS.COM  
**Domino's is now hiring  
pizza delivery drivers.**

[LEARN  
MORE](#)

[Like](#)  [Comment](#)  [Share](#)



Become a driver at Instacart and deliver groceries.



SHOPPERSINSTACART.COM  
**Instacart is now hiring  
grocery delivery drivers.**

[LEARN  
MORE](#)

[Like](#)  [Comment](#)  [Share](#)



B. Imana, A. Korolova, and J. Heidemann, *Auditing for Discrimination in Algorithms Delivering Job Ads*, (2021)



ACTION.DONALDJTRUMP.COM  
**WORKING FOR THE PEOPLE**  
ADD YOUR NAME >>>>

SIGN  
UP

Like

Comment

Share



ACT.BERNIESANDERS.COM  
**Add your name to show you  
support Bernie.**

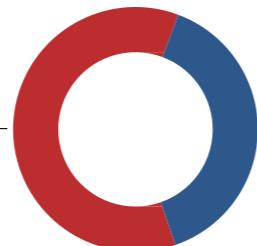
SIGN  
UP

Like

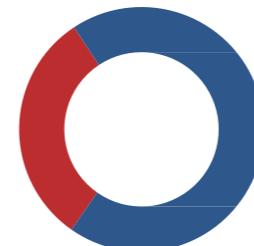
Comment

Share

61% Republican



69% Democratic



M. Ali\*, P. Sapiezynski\*, A. Korolova, A. Mislove, and A. Rieke, *Ad Delivery Algorithms: The Hidden Arbiters of Political Messaging*, (2021)

# Not Every Audit is Negative

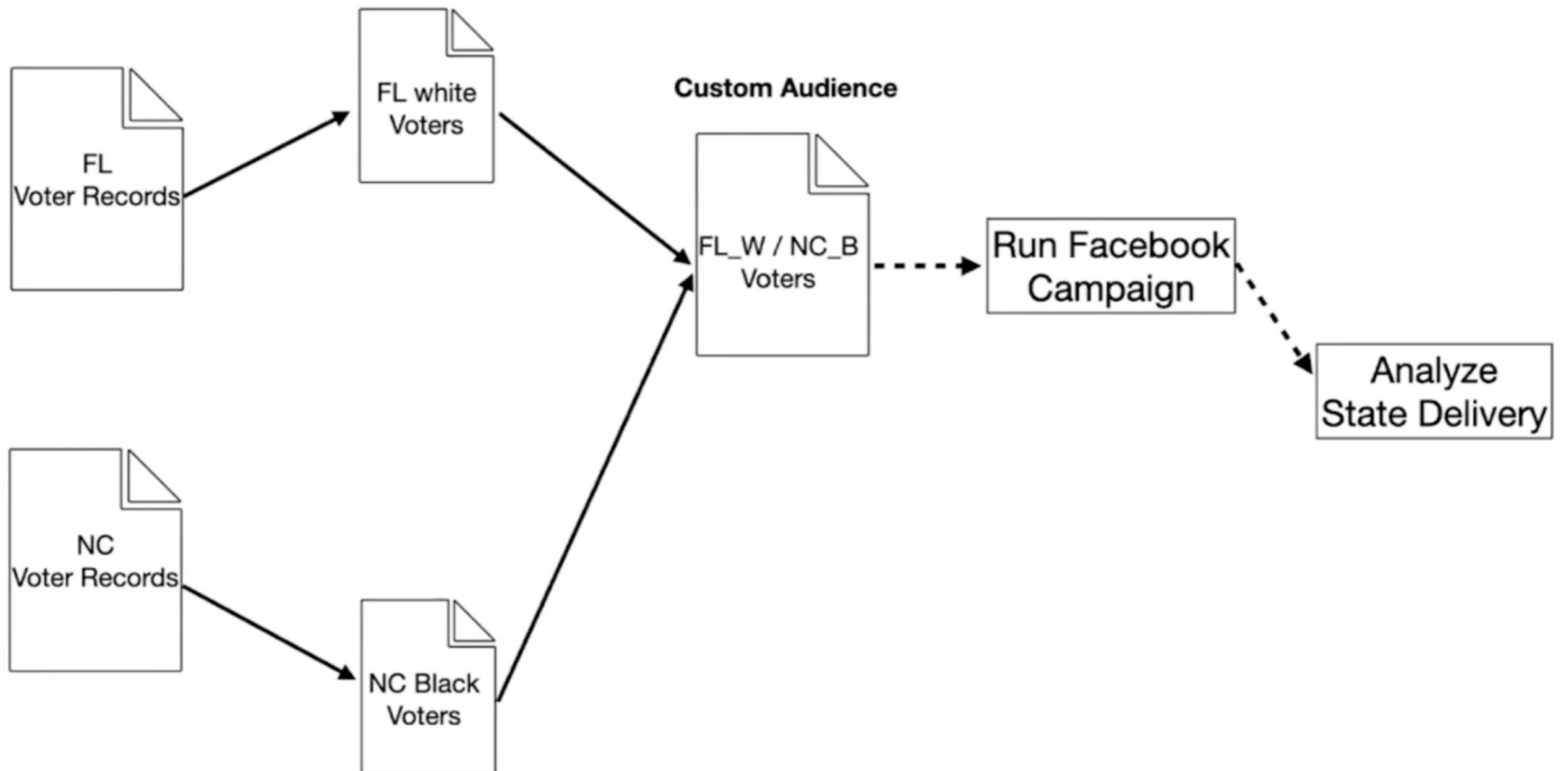
- Members of Congress and the US President have accused online platforms of political bias
  - “Google Search censors conservative news sources”
  - “Social media censors conservative voices”
- These are scientifically testable hypotheses
- Google Search is not politically biased
  - Search results reflect the prevailing media ecosystem, which leans slightly left in the US
- Comment moderation on YouTube is not politically biased
  - More moderation on conservative videos, but...
  - Also greater prevalence of hate speech and mis/disinformation

# Challenges

- Platforms do not share all relevant data for testing fairness. E.g., Facebook not sharing race info for ad delivery

But it shares location

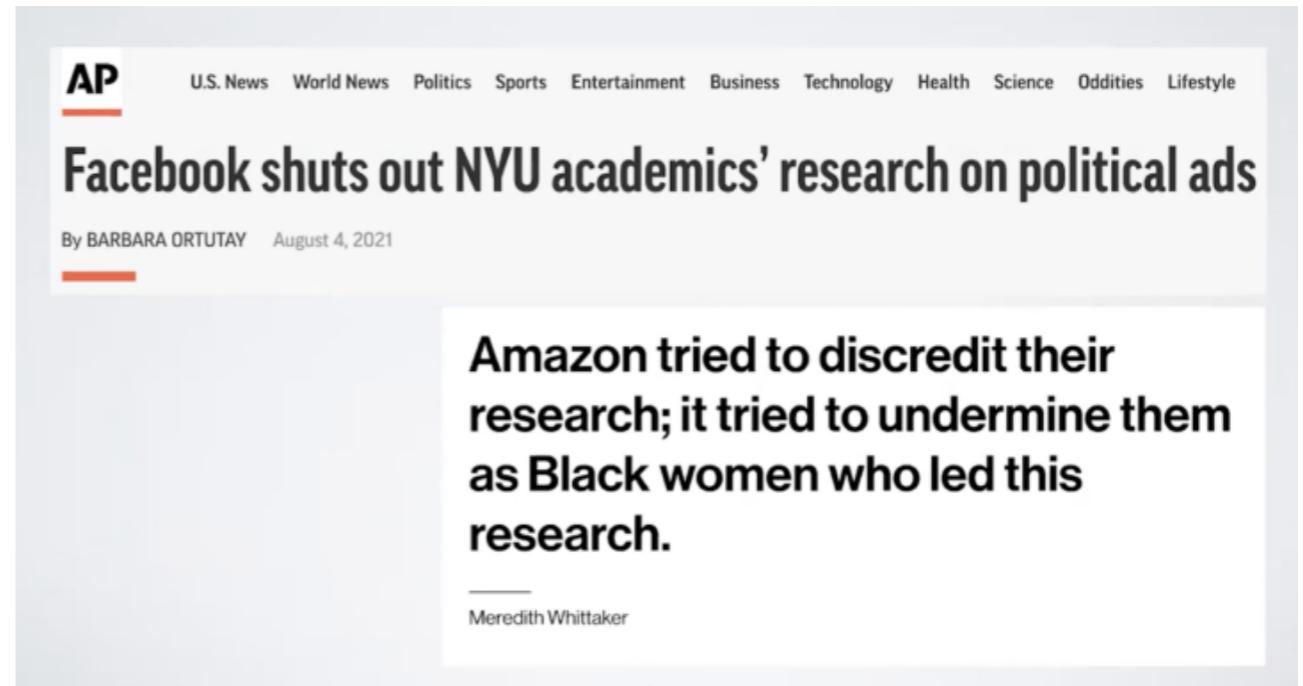
- Trick: Use public voter records to create custom audiences with race and location



"Discrimination through Optimization: HowFacebook's Ad Delivery Can Lead to Biased Outcomes", Ali et al., 2019

# Challenges

- Platforms have arbitrary rules that create barriers: minimum spending limit for access to relevant factors for Google if 50K
- Advertisers and their ads can get banned
- Or they can detect and change their results to evade tests
- Cost



# Alternatives

- Use sock puppet accounts
- Crowdsourcing: Get users to install a web browser extension/mobile app

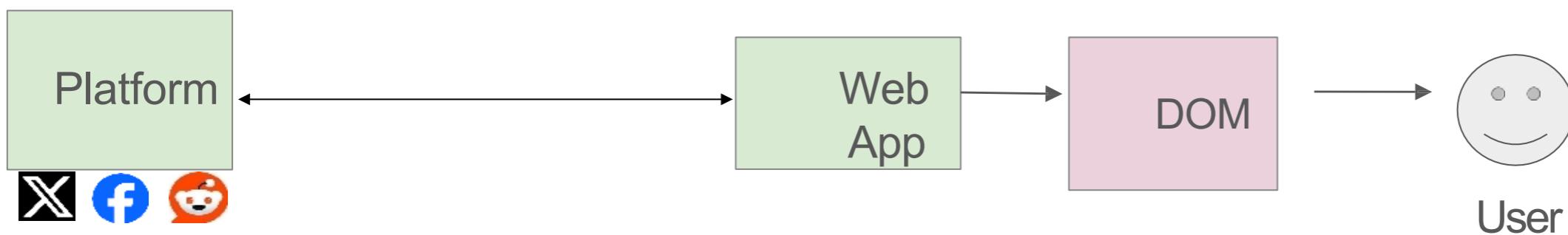
The Prosocial Ranking Challenge - \$60,000 in prizes for better social media algorithms

18 Jan 2024



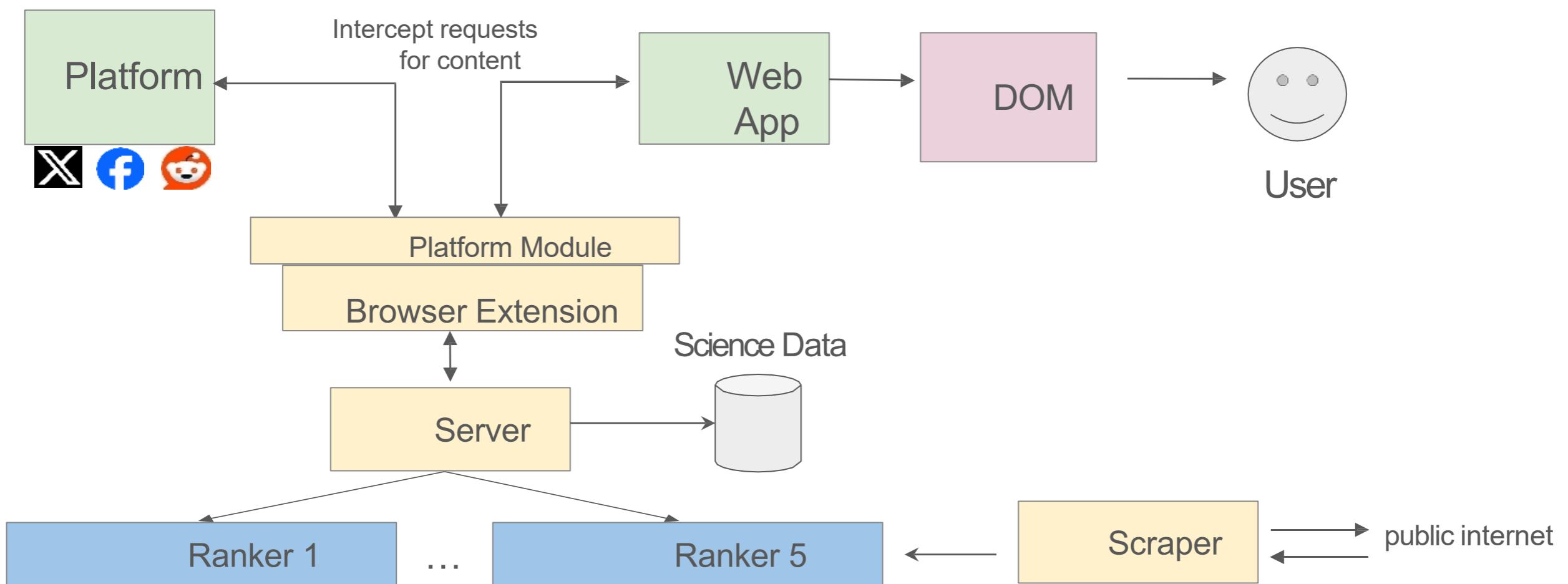
# System Design

Participants are asked to install a **browser extension** to both change what they see on social media and track their behavior



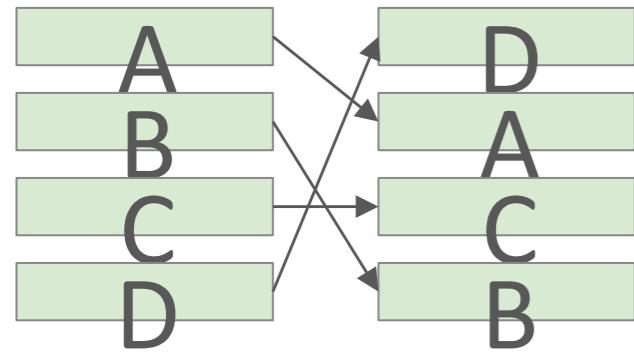
# System Design

Participants are asked to install a **browser extension** to both change what they see on social media and track their behavior

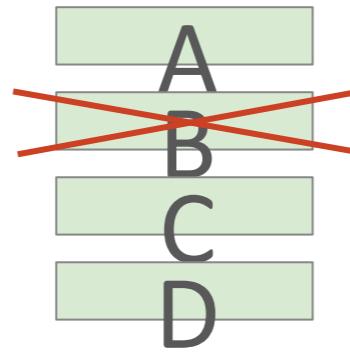


# System Design

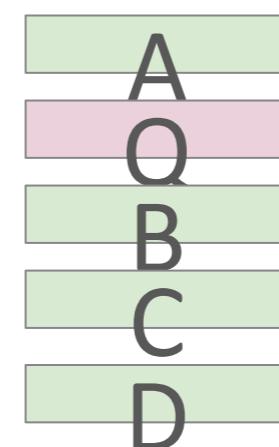
Participants are asked to install a **browser extension** to both change what they see on social media and track their behavior



Re-order



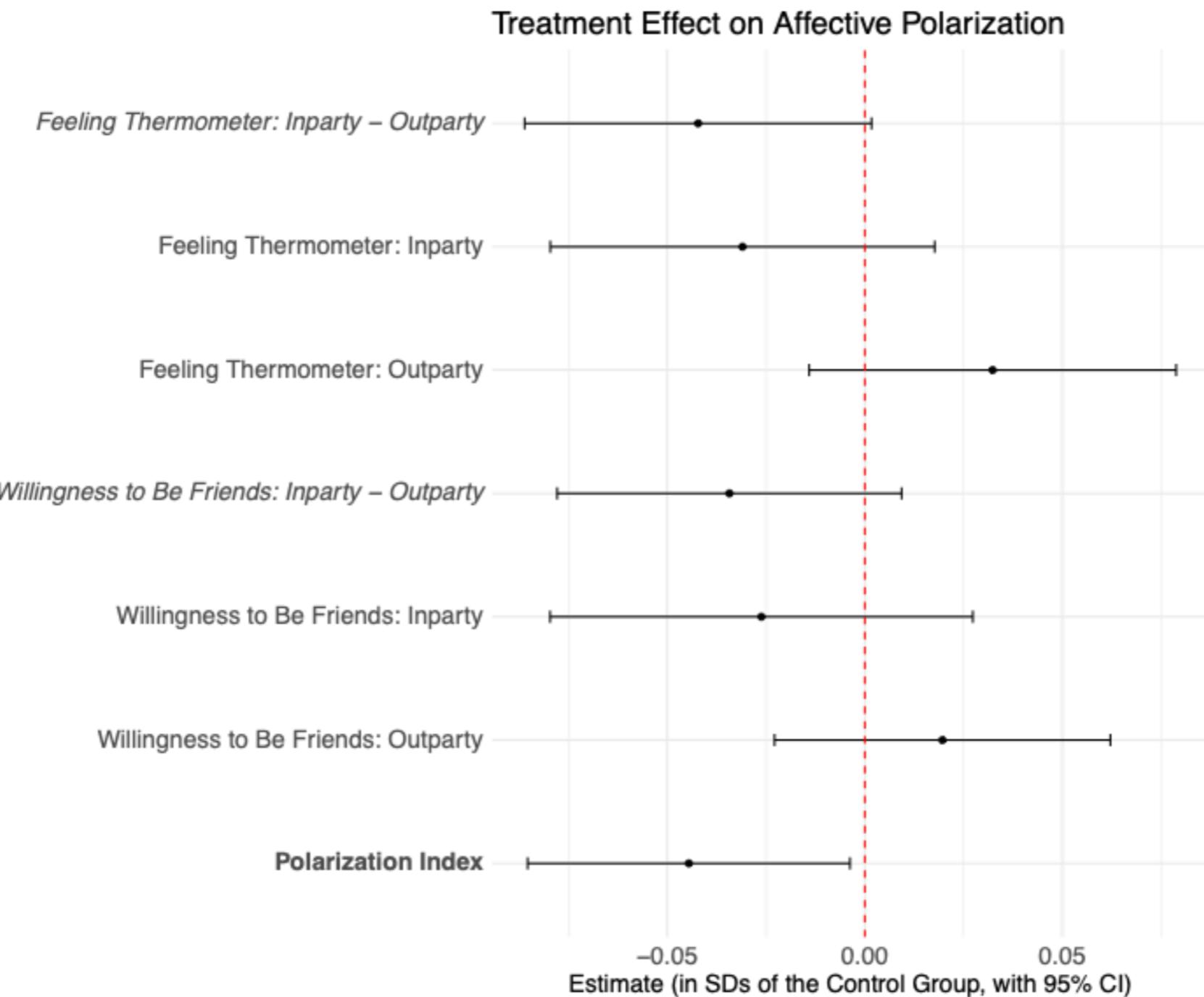
Remove



Add

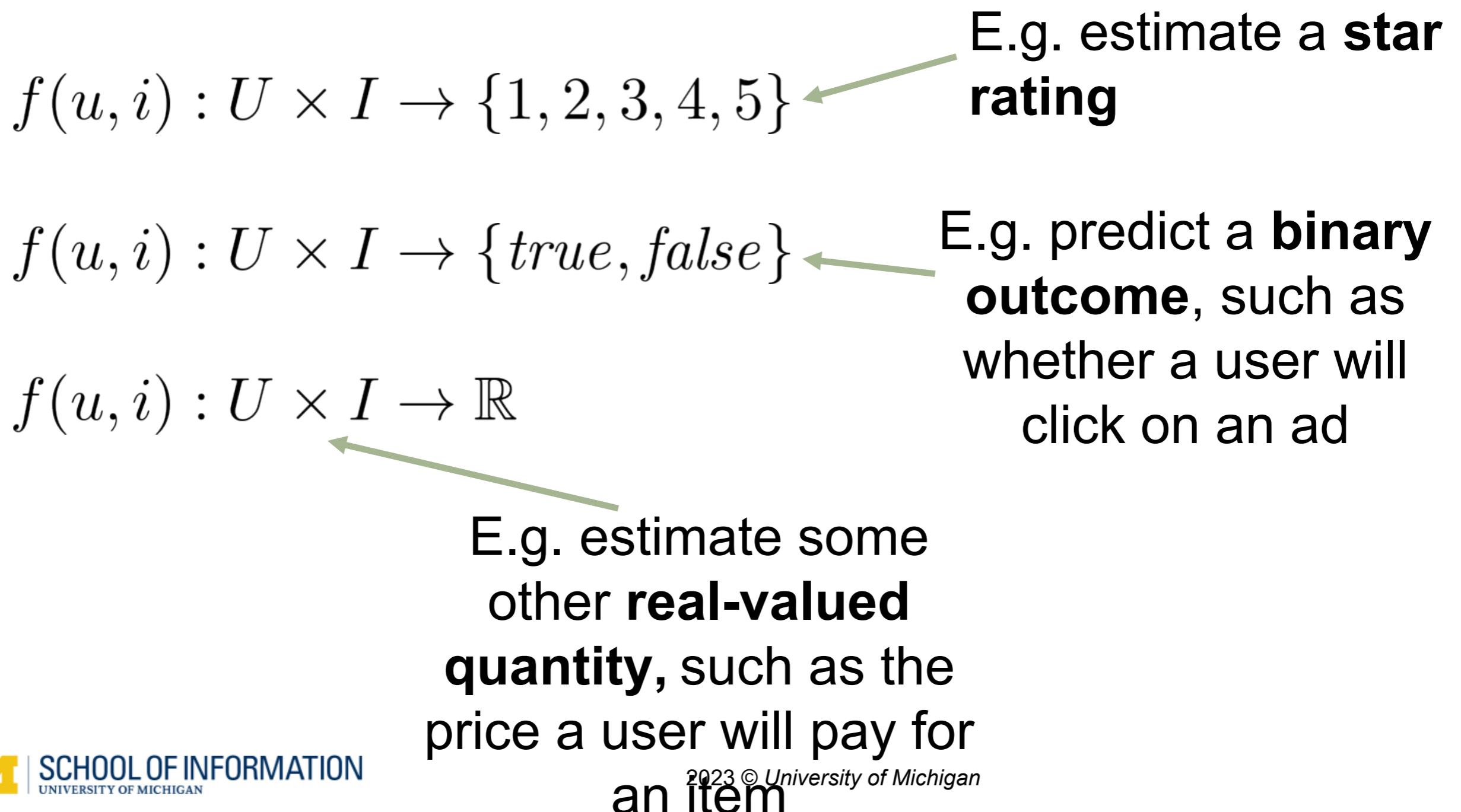
- The first 50 content items displayed to a user, for each page load, for each platform, are subject to intervention. We tested 5 interventions.

# A slice of results



# Fairness in Recommender Systems

# Technical setup



# Technical setup

e.g. if we can model  
 $f(\text{user}, \text{movie}) \rightarrow \text{star rating}$

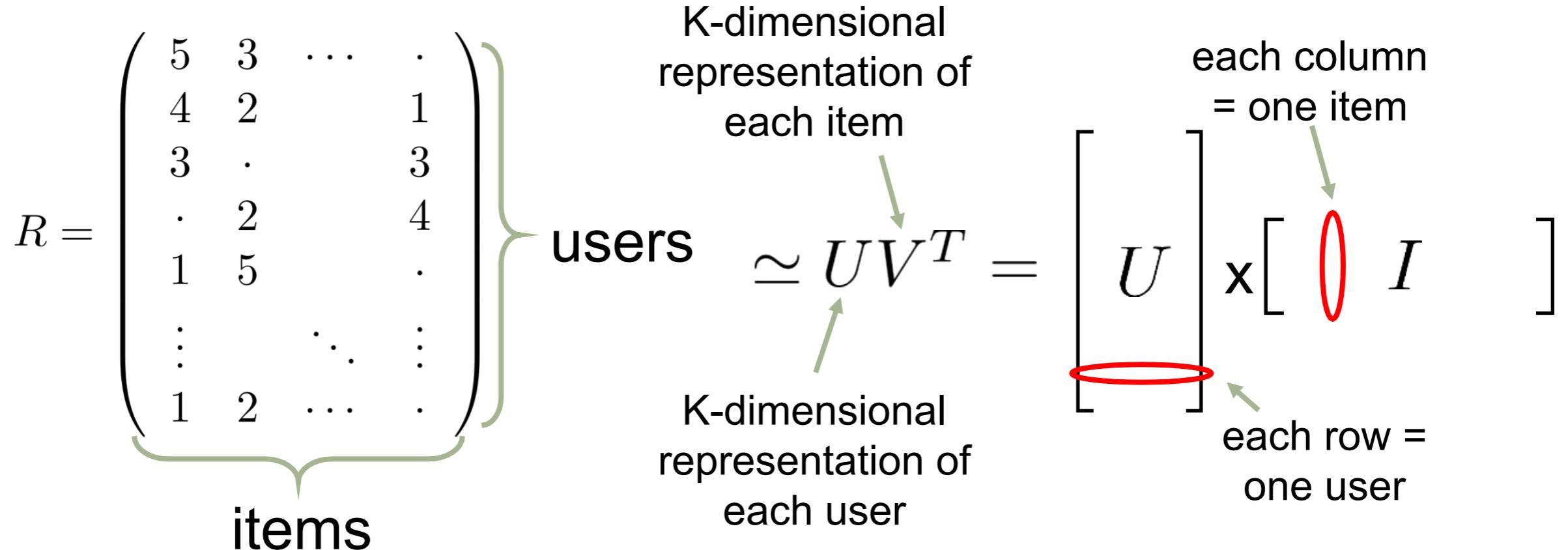


Then recommendation  
will consist of identifying

$$\text{recommendation}(u) = \arg \max_{i \in \text{unseen items}} f(u, i)$$

# Latent-factor models

A common solution that we'll build upon is based on **matrix factorization:**



# Latent-factor models

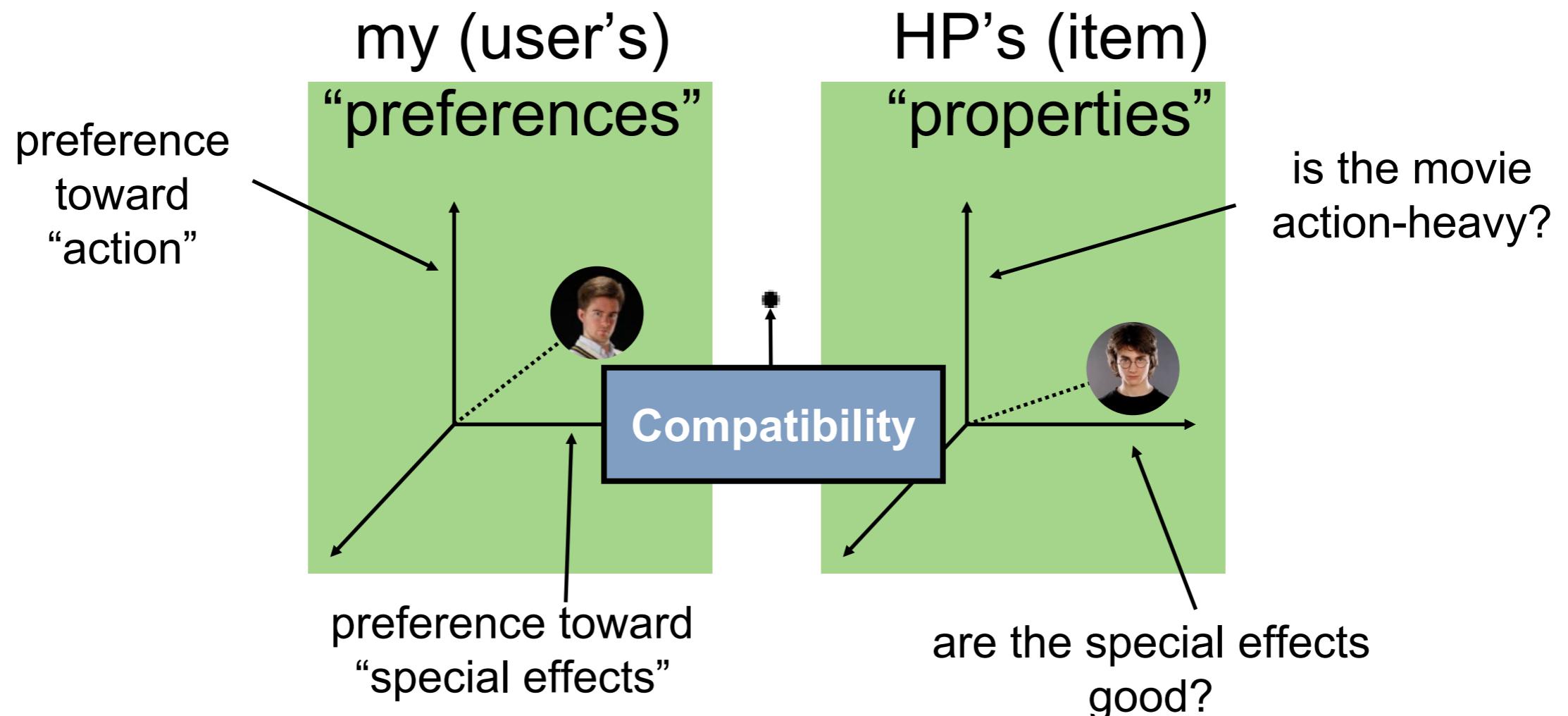
We'd like to train the model to be as accurate as possible.

E.g. for rating prediction:

$$\arg \min_{\alpha, \beta, \gamma} \sum_{u,i} (\underbrace{\alpha + \beta_u + \beta_i + \gamma_u \cdot \gamma_i}_{\text{model}} - \underbrace{R_{u,i}}_{\text{actual value}})^2$$

# Latent-factor models

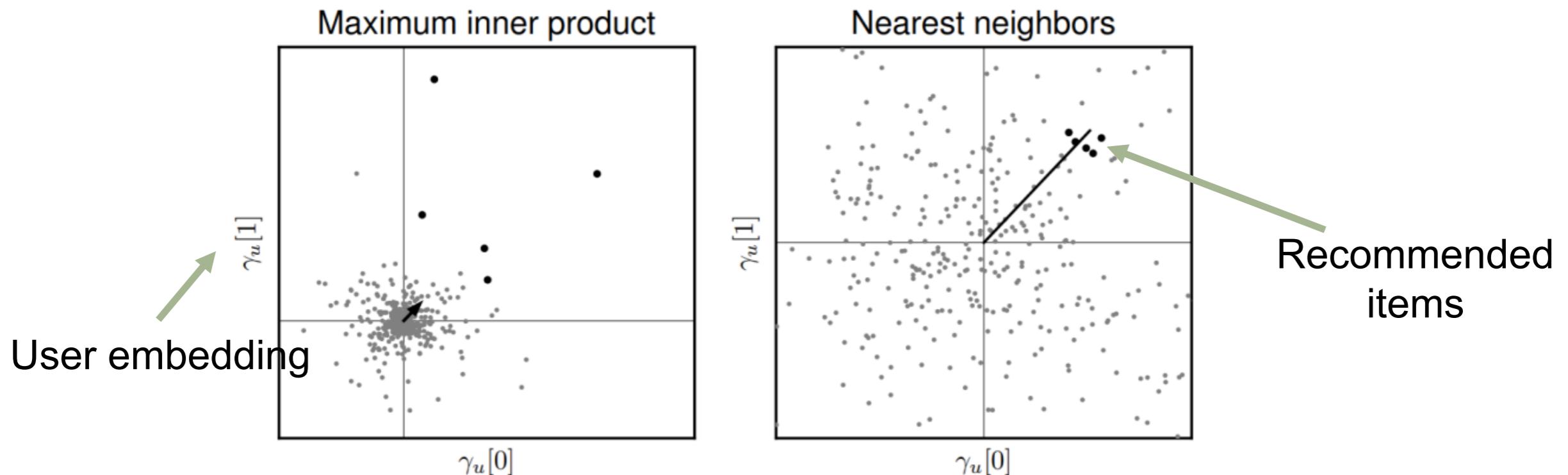
Now we have a **vector** describing each user, and a **vector** describing each item



# What are fairness issues in personalized algorithms?

- Recommender systems may have a 'concentration' effect, where users are gradually locked into a 'filter bubble' containing only a narrow set of items
- Recommending content maximally aligned with a user's interests may gradually push users toward more and more 'extreme' content
- Recommender systems may have reduced utility for users (or groups of users) who are underrepresented in the training data
- Recommendations may focus only a user's predominant interest, while failing to capture the diversity and breadth of their interactions
- Systems could disadvantage vendors (or content creators, etc.) by failing to recommend products in the long-tail

# What problematic outcomes could recommenders have?



Consider recommending items by taking the maximum inner product versus a nearest neighbor

$$rec(u) = \arg \max_{i \in I \setminus I_u} f(u, i)$$

$$f(u, i) = \|\gamma_u - \gamma_i\|$$

# What problematic outcomes could recommenders have?

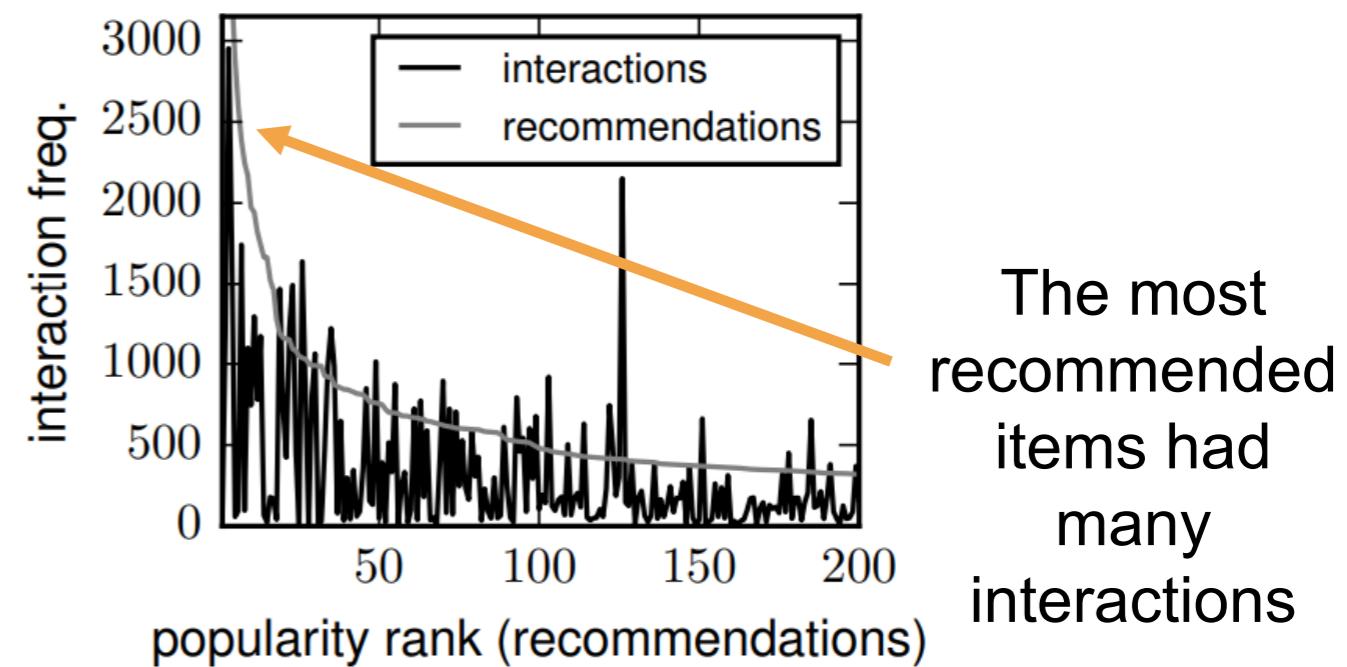
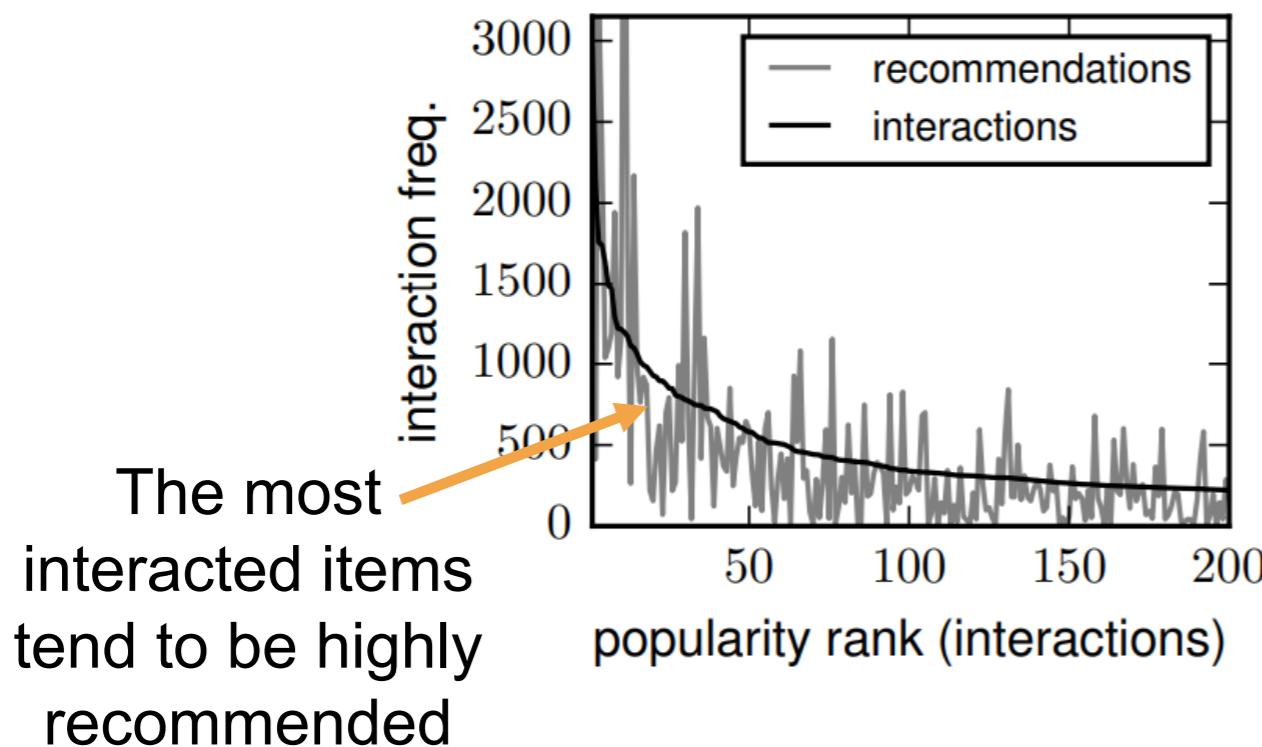
- Maximizing the inner product will tend to recommend "extreme" items: if I like action, I should like a lot of action
- Finding nearest neighbors will tend to recommend items that are very close to what I've already consumed
- How can we measure (and maybe correct) these issues with content extremity / diversity?

# Diversity in recommendation

- Motivating exercise:
  - Are items that were consumed a lot the same as the ones that tend to be recommended a lot? How well do consumptions and recommendation distributions overlap?
  - What about the shape of the distribution? Are recommendations dominated by popular items (moreso than consumptions?)

# Diversity in recommendation

## Consumption vs recommendation distribution (Goodreads)



Distributions match okay, but top-recommended items appear *much* more than their number of historical interactions!

See book: <https://cseweb.ucsd.edu/~jmcauley/pml/> chapter 10 for more and code!

# Concentration

- The most-recommended items were a fair bit more popular than the most consumed items
  - i.e., the recommender made popular items more popular
- This is known as a **concentration effect**: recommendations may concentrate around a few items (and this could cause a feedback loop!). Can measure by e.g. Gini coefficient

# Concentration & diversity

- From some real studies:
  - Fleder and Hosanagar, 2009: Simulate users (can accept or reject recommendations), with recommenders trained on interaction history. Over time, recommendations become more and more concentrated
  - Nguyen et al. 2014: For real users, both recommendations and interactions become less diverse over time (in terms of content features)

# Concentration & diversity

- From some real studies:
  - Extremification (Ribeiro 2020, youtube): How do recommendations on youtube guide users to extreme content? E.g. if users visit pages that have a specific slant (but are not "extreme"), will they gradually be guided to more extreme pages?
  - Content diversity (Zhou 2010, youtube): Recommendations drive a large fraction of views, and are more diverse than what would be expected by popularity-driven models

# Content diversity over time (Bakshy et al. 2015)

- Bakshy et al. (2015) studied the extent to which recommendations on facebook reinforce users' political ideology
- Main questions:
  - How much do recommenders **expose** users to diverse content?
  - How much do users **interact** with cross-cutting content?

# Content diversity over time (Bakshy et al. 2015)

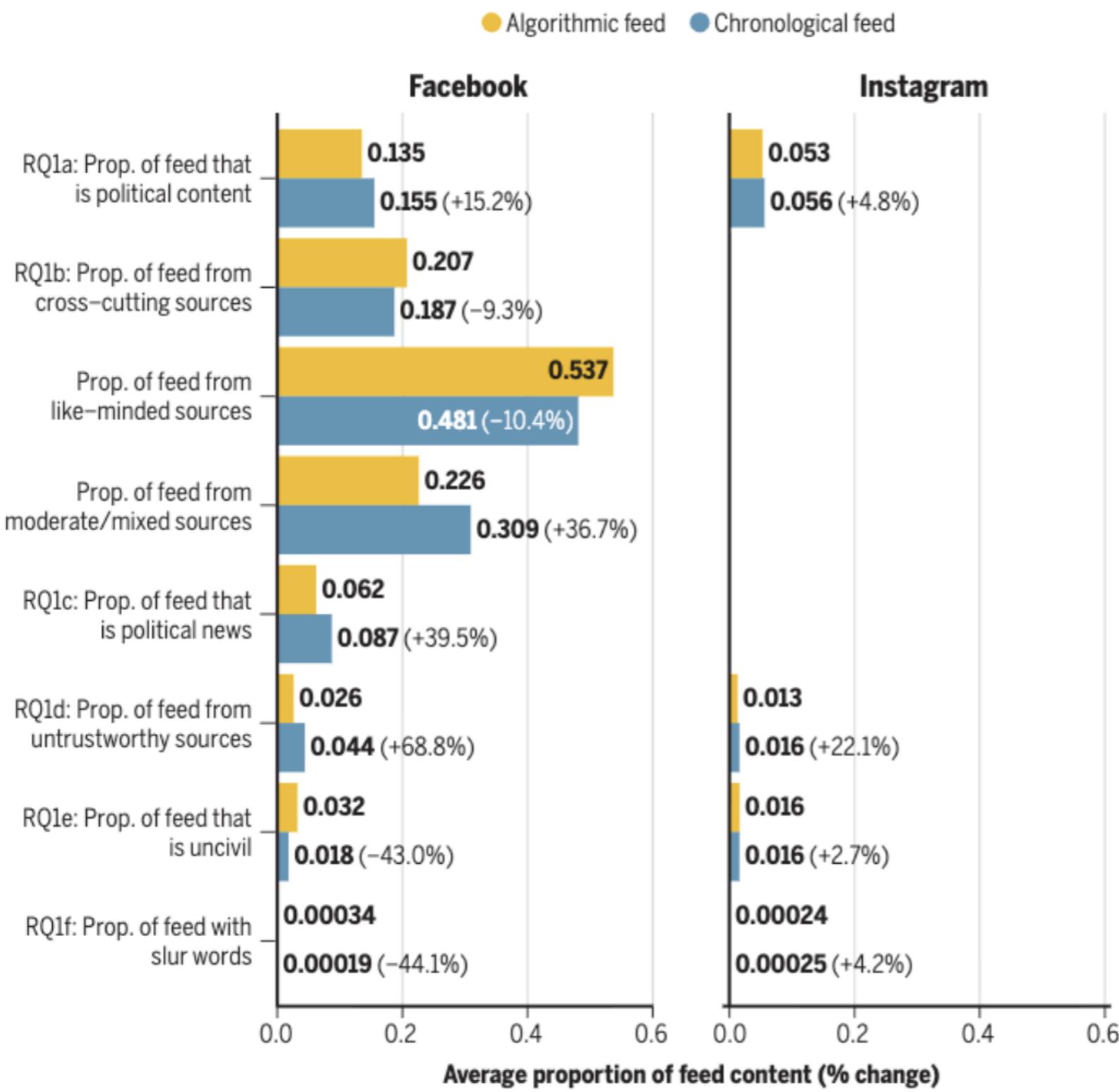
- How much do recommenders **expose** users to diverse content?
  - Various challenges: e.g. labeling content ("liberal"/"conservative"/"neutral"), and dealing with exposure bias (e.g. liberal people have liberal friends, so are exposed to liberal content), so naturally most content is not cross-cutting

# Content diversity over time (Bakshy et al. 2015)

- How much do recommenders **expose** users to diverse content?
  - Algorithmic ranking indeed exposes users to less ideologically diverse news than would be expected by the ideological makeup of their social group

# Content diversity over time (Bakshy et al. 2015)

- 2. How much do users **interact with** cross-cutting content?
  - Users interact with ideologically diverse content at an even lower rate than their rate of exposure.
  - Arguably, individual choice plays the largest role in users' exposure to content that is ideologically homogeneous (according to facebook!)



*“How do social media feed algorithms affect attitudes and behavior in an election campaign?” Guess et al., Science, 379(6625), eabp9364. doi:10.1126/science.abp9364*

Fig. 2. Estimated changes in prevalence of feed content on both Facebook and Instagram. (Left)

# IR + diversifying/debiasing

# Re-ranking strategies to diversification

- A simple way to make recommendations more "diverse" is just to (post-hoc) rerank the outputs of some recommender
- Note that diversity could mean a few things:
  - Is there variety among the **set of items** a user is recommended?
  - Across all users, are different items recommended to **different people**?

# Maximal marginal relevance (MMR)

- 1. Is there variety among the set of items a user is recommended?
- Basic strategy (Carbonell and Goldstein, 1998):
  - Start with the most relevant item
  - Repeatedly select the next most relevant item, but penalize relevance if it's too similar to already selected items
  - Repeat until we have the desired number of items

# Maximal marginal relevance (MMR)

- 1. Is there variety among the set of items a user is recommended?
- Basic strategy (Carbonell and Goldstein, 1998):

$$MMR = \arg \max_{i \in R \setminus S} \left[ \lambda \underbrace{Sim^{\text{user}}(i, u)}_{\text{relevance to the user}} - (1 - \lambda) \overbrace{\max_{j \in S} Sim^{\text{item}}(i, j)}^{\text{similarity to already-recommended items}} \right],$$

Large lambda: only care about relevance

Small lambda: only care about diversity

# Quiz Time

# IR + diversifying/debiasing 2

# How is fairness in recommendation different?

- Recall we're optimizing something like:

$$\arg \min_{\alpha, \beta, \gamma} \sum_{u,i} (\alpha + \beta_u + \beta_i + \gamma_u \cdot \gamma_i - R_{u,i})^2$$

- i.e., we're making personalized recommendations to each user based on some model
- In what ways could such a model be problematic, unbiased, or unfair?

# How is fairness in recommendation different?

- Yao & Huang (2017) studied fairness in a recommendation setting based on online course evaluations of CS classes

- Model is of the form

$$\arg \min_{\alpha, \beta, \gamma} \sum_{u,i} (\alpha + \beta_u + \beta_i + \gamma_u \cdot \gamma_i - R_{u,i})^2$$

- What might happen if females (or any group) is highly underrepresented in this type of data?

# How is fairness in recommendation different?

- E.g. the underrepresented group might have their ratings over or underpredicted ("value unfairness")

$$U_{\text{val}} = \frac{1}{|I|} \sum_{i=1}^{|I|} \left| \left( \underbrace{\mathbb{E}_g[y]_i - \widetilde{\mathbb{E}_g[r]}_i}_{\text{expected prediction for group } g \text{ on item } i} \right) - \left( \mathbb{E}_{\neg g}[y]_i - \mathbb{E}_{\neg g}[r]_i \right) \right|$$

average rating for group  $g$  on item  $i$

↑

Misprediction for males

↑

Misprediction for females

- (equation is a mouthful but it's just the difference of mispredictions for the two groups)

# How is fairness in recommendation different?

- We could measure related quantities in various ways:

$$U_{\text{abs}} = \frac{1}{|I|} \sum_{i=1}^{|I|} \left| \left| \mathbb{E}_g[y]_i - \mathbb{E}_g[r]_i \right| - \left| \mathbb{E}_{\neg g}[y]_i - \mathbb{E}_{\neg g}[r]_i \right| \right|$$

$$U_{\text{under}} = \frac{1}{|I|} \sum_{i=1}^{|I|} \left| \max\{0, \mathbb{E}_g[r]_i - \mathbb{E}_g[y]_i\} - \max\{\mathbb{E}_{\neg g}[r]_i - \mathbb{E}_{\neg g}[y]_i\} \right|$$

$$U_{\text{over}} = \frac{1}{|I|} \sum_{i=1}^{|I|} \left| \max\{0, \mathbb{E}_g[y]_i - \mathbb{E}_g[r]_i\} - \max\{\mathbb{E}_{\neg g}[y]_i - \mathbb{E}_{\neg g}[r]_i\} \right|$$

# Disparity in recommendation

- Ultimately each is a form of **disparity** between the two groups
- First main point is that such disparities are manifest in real datasets with standard recommendation approaches (most experiments are on movie recommendation, across categories that exhibit different levels of gender imbalance)

# Disparity in recommendation

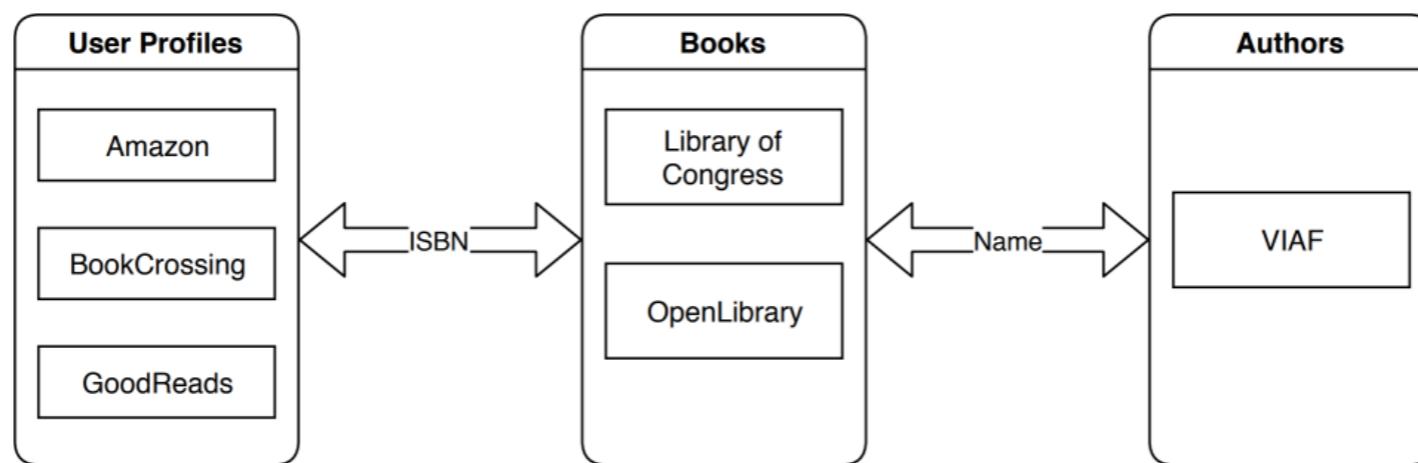
- Second point is that these fairness objectives can be incorporated into training with little loss in performance:
- e.g.:

$$\frac{1}{\bar{\mathcal{T}}} \sum_{(u,i) \in \mathcal{T}} \underbrace{(\alpha + \beta_i + \beta_u + \gamma_i + \gamma_u - R_{u,i})^2}_{\text{accuracy}} + \lambda \underbrace{U_{\text{abs}}}_{(\text{absolute}) \text{ fairness}}.$$

# IR + diversifying/debiasing 3

# Gender bias in book recommendations

- Ekstrand and Kluver (2019) explored gender in book recommendations, on Amazon, BookCrossing, and GoodReads
- Review data is available, but some considerable effort to extract author gender



# Gender bias in book recommendations

- Various research questions:
  - RQ1/2: To what extent are female authors over/underrepresented in the dataset (1) and among users' consumption patterns (2)
  - RQ3/4: To what extent do recommenders mimic or exacerbate any imbalance?
  - RQ5: Can this be algorithmically corrected, and what is the cost in doing so?

# Aside: C-, P-, and CP-fairness

- In recommender systems, fairness can be viewed from multiple perspectives (Burke, 2017):
  - consumer (C)
  - the producer (P)
  - or both (CP)

# RQ 1/2 (gender in data and interactions):

- Male-authored books are overrepresented; less so in interactions (and in fact less than an ostensible distribution of all authors); individual users are quite diverse

	Data	Books		Ratings	
		female	male	female	male
Library of congress	LOC	22.7%	77.3%	—	—
Amazon	AZ	30.6%	69.4%	38.9%	61.1%
BookCrossing ratings	BX-E	40.5%	59.5%	43.0%	57.0%
all interactions	BX-I	40.7%	59.3%	45.7%	54.3%
GoodReads	GR-E	37.8%	62.2%	47.6%	52.4%
	GR-I	37.7%	62.3%	48.2%	51.8%

# RQ 5 (algorithmic correction):

- Rather than correcting this bias during training (like in Yao & Huang), bias is corrected using a post-hoc reranking strategy
- Strategy(ies) are simple greedy algorithms that recommend items with high utility while enforcing a balance constraint (note: this is what might be called "affirmative action" in the fairness literature)
  - E.g. SingleEQ: for each item in the input base algorithm ranking (in order) the algorithm either accepts the item (adding it to the output list of items) or reject it. Items are rejected if they would make the gender balance of the current output list further from our target.

# Summary

- Fairness in recommendation has quite different metrics / goals than traditional fairness problems
- Most have to do with loss of utility for certain groups, and ensuring that recommenders don't make things worse
- Straightforward correction strategies that balance fairness objectives with recommendation utility
- Topic is still quite new and open!
  - Lots of other related perspectives: e.g. calibration, filter bubbles, content diversity, extremification

# Summary

- Lots of other related perspectives:
  - Recommendations should be calibrated across attributes or categories
  - Recommendations should be serendipitous, unexpected, or novel (rather than just relevant)
  - Recommendations should be appropriately balanced across items
  - Etc.

# What you need to know

- How we decide on meta-data, human-labeled or algorithmically-labeled, has consequences
- Personalized data is used widely in industry
  - But unknown how exactly
- Algorithmic audits are a popular and often effective way to spot disparity
  - But hard to scale up!
- Recommender systems raise many new issues in fairness like access, diversity, filter bubbles
- Fairness can be directly incorporated into our ML methods—often improving the IR system's results!