Invisible Knowledge and the Internet

Estimation and Implications

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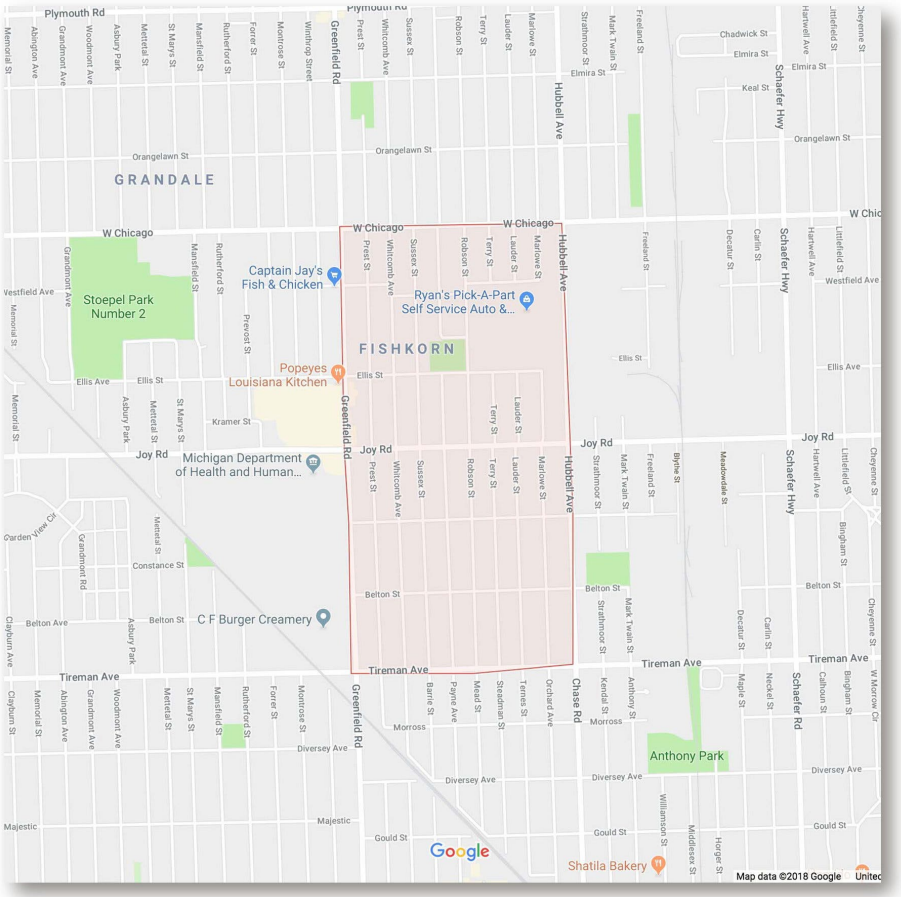
December 10, 2021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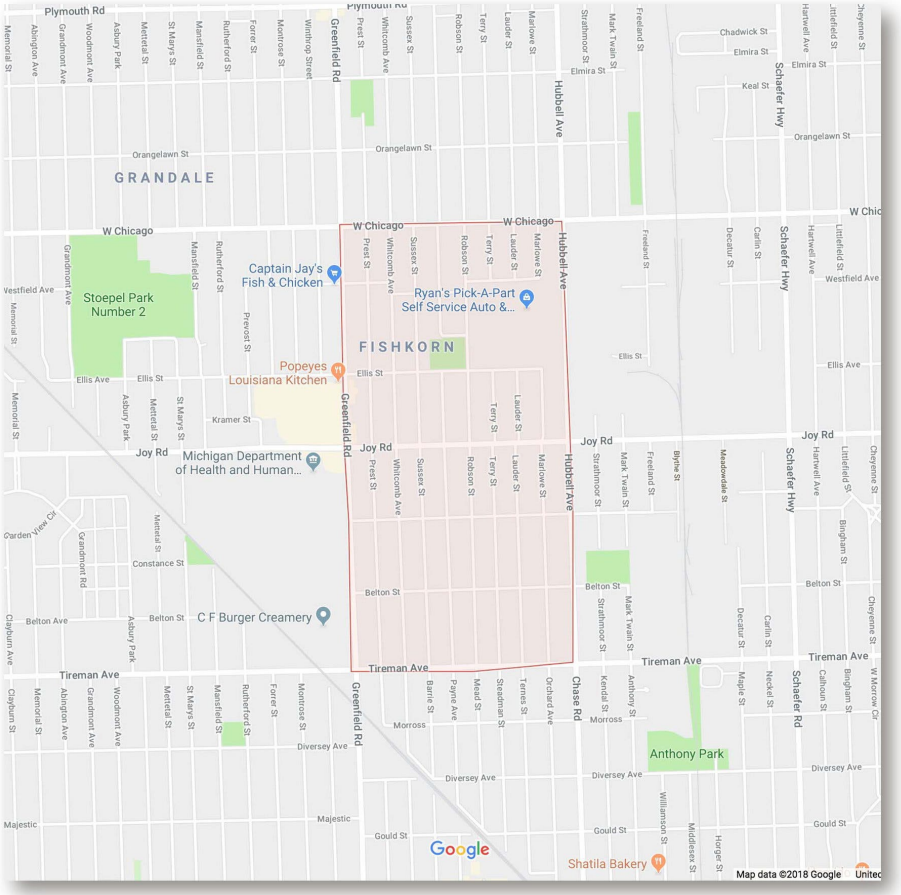
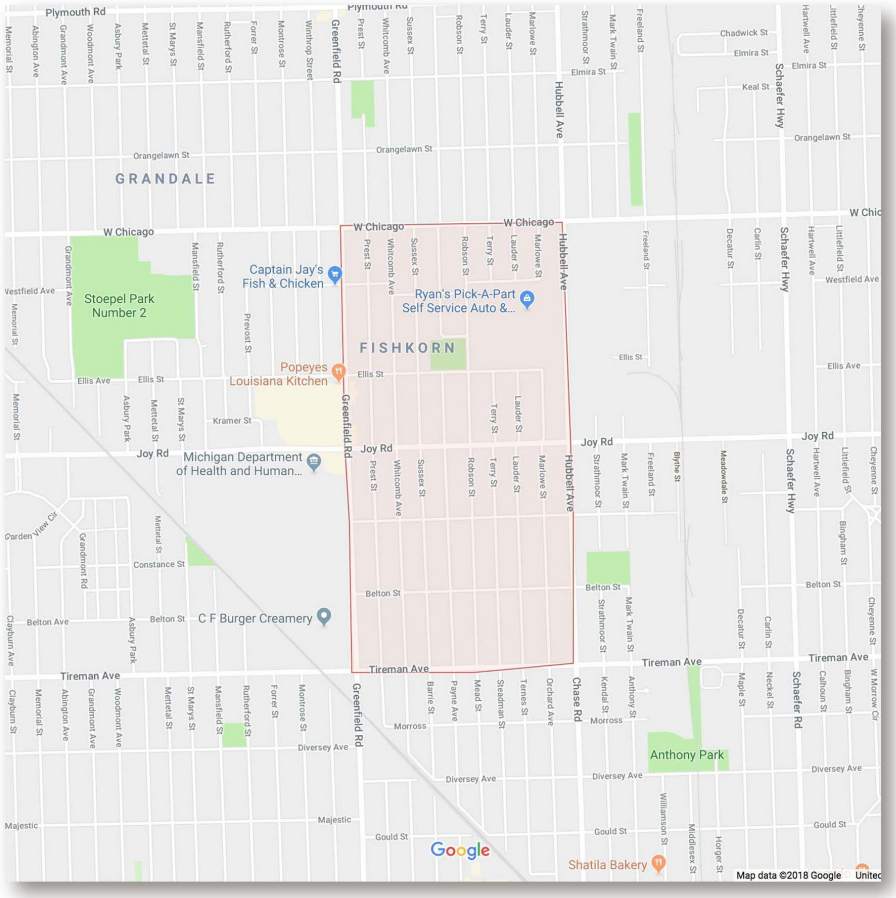


Fis*k*-*h*orn → Fis*h*-*k*orn



The New York Times

As Google Maps Renames Neighborhoods, Residents Fume

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Fis*k*-*h*orn → Fis*h*-*k*orn [2012-18] → Fis*k*-*h*orn

(Independent) Knowledge Access

Peer
interaction/Libraries

(Independent) Knowledge Access

Peer interaction/Libraries

Internet Search

Internet Search

- 1998: *Indexer of human knowledge*
- 2004–15:
  - Begin courting university libraries
  - Authors Guild, Inc. v. Google, Inc.
  - $40M$ books digitized $\rightarrow 130M$
  - Queried 40,000 times every second
- 2019 – ?
  - 47% rise in broadband usage
  - ~~32%~~ 62% US parents report teens' daily internet use exceeding four hours
- Present: *Provider of human knowledge*

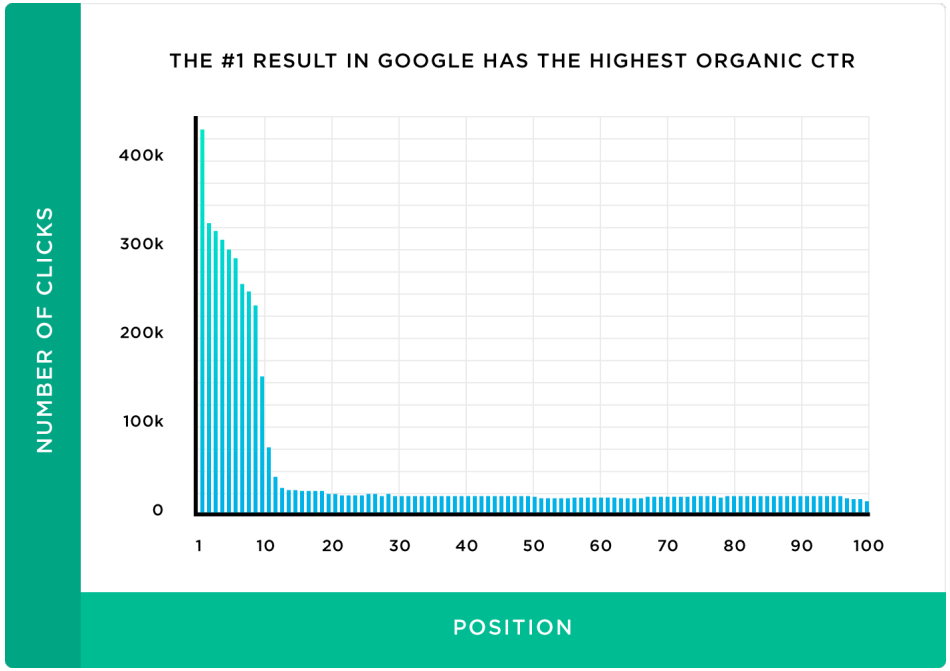
Three Problems

Problem 1

Much stays invisible

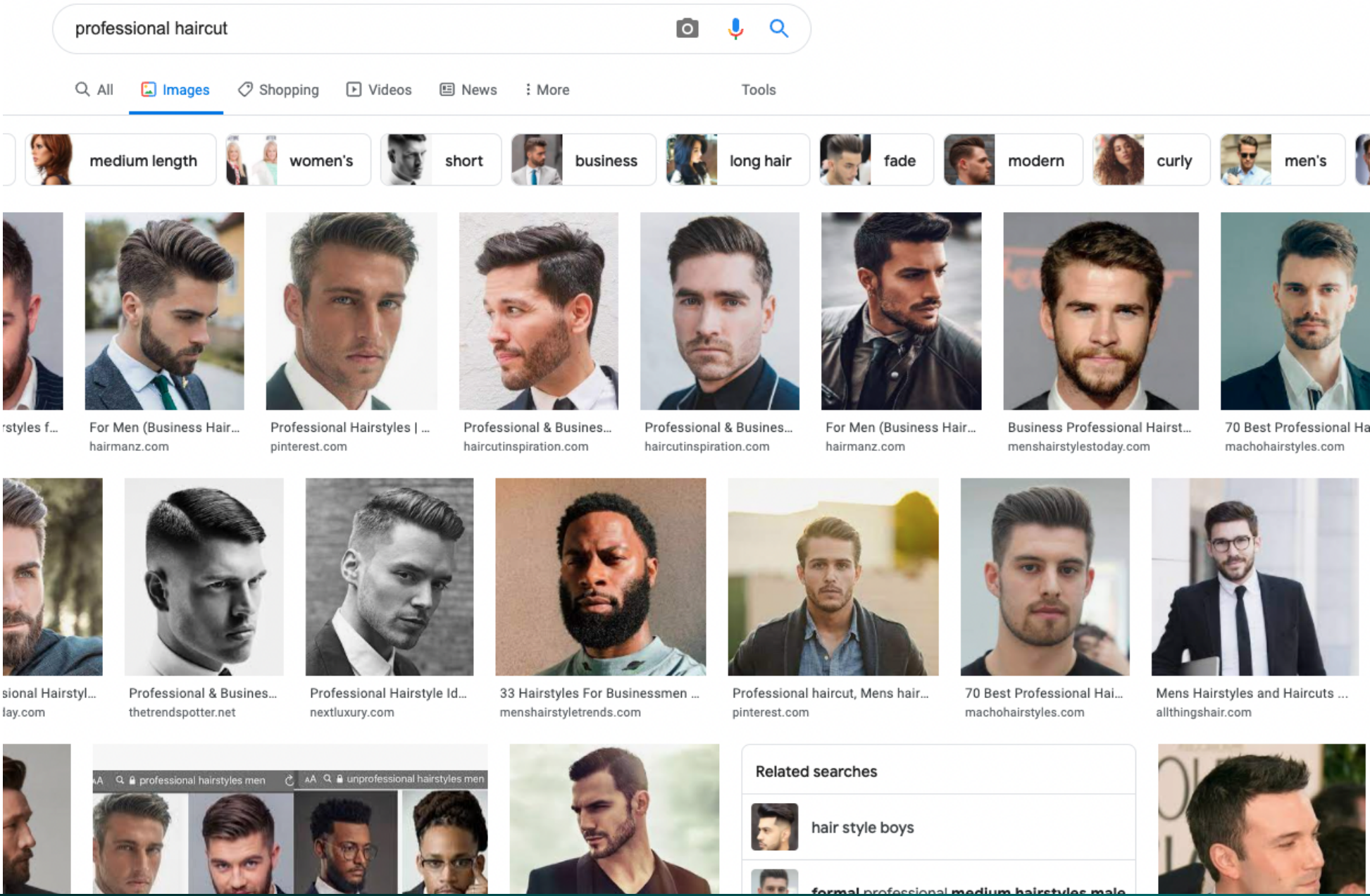
In the context of internet search[1]:

- 91% of pages get no organic search traffic
- First result on page 2 receives only 1% of all clicks
- First page of search results receives 95% of all clicks



[1] European Commission v Google 2017

Problem 2


professional haircut
All
Images
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News
More
Tools
medium length
women's
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business
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hairmanz.com
Business Professional Hairst...
menshairstylestoday.com
70 Best Professional Ha
machohairstyles.com
Professional & Busines...
thetrendspotter.net
Professional Hairstyle Id...
nextluxury.com
33 Hairstyles For Businessmen ...
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Professional haircut, Mens hair...
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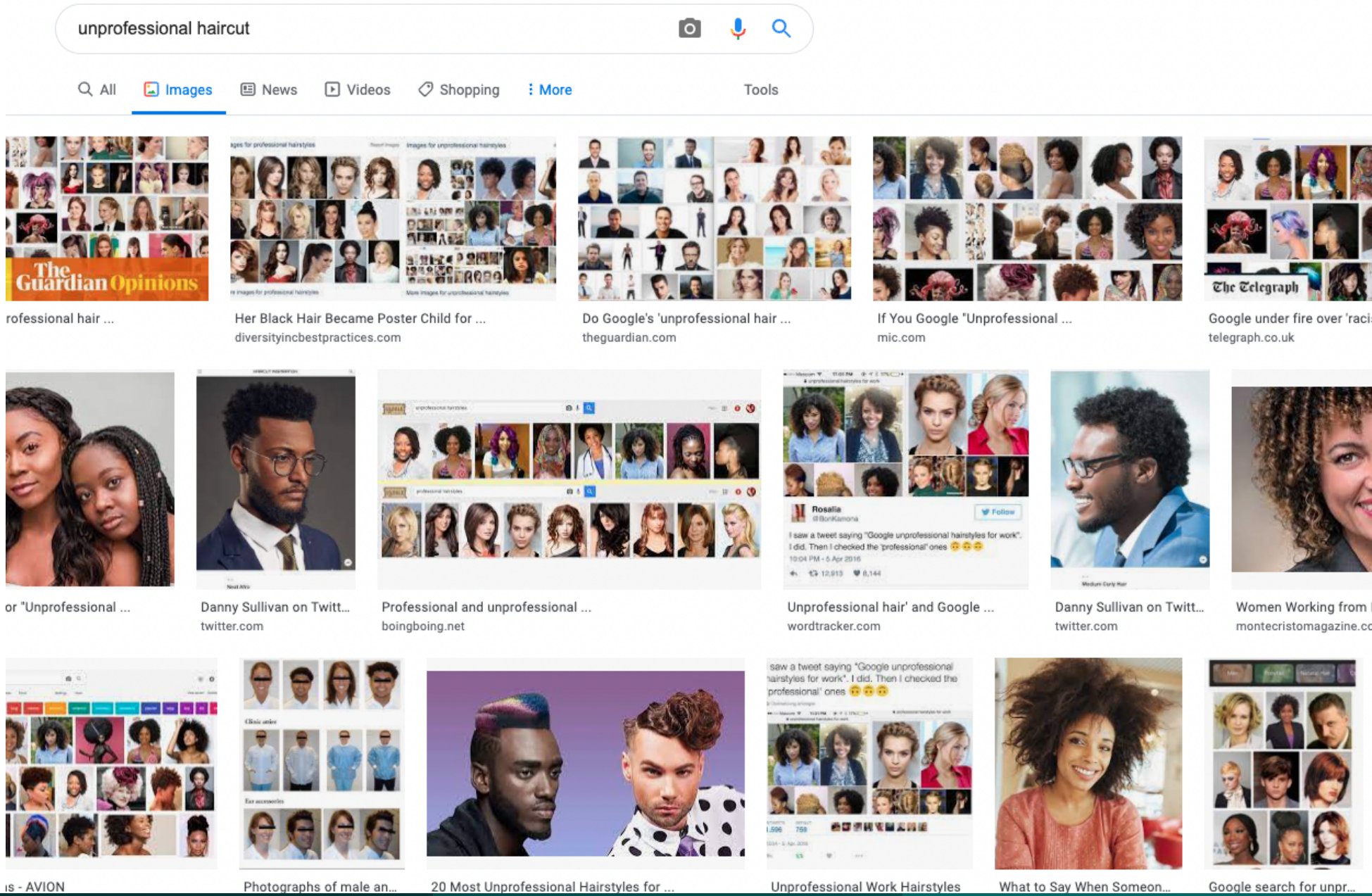
professional hairstyles men
unprofessional hairstyles men
Related searches
hair style boys

Problem 2


unprofessional haircut
All
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The Guardian Opinions
rofessional hair ...
Her Black Hair Became Poster Child for ...
diversityincbestpractices.com
Do Google's 'unprofessional hair ...
theguardian.com
If You Google "Unprofessional ...
mic.com
The Telegraph
Google under fire over 'raci
telegraph.co.uk
or "Unprofessional ...
Danny Sullivan on Twitt...
twitter.com
Professional and unprofessional ...
boingboing.net
Rosalia
I saw a tweet saying "Google unprofessional hairstyles for work". I did. Then I checked the "professional" ones
Unprofessional hair' and Google ...
wordtracker.com
Danny Sullivan on Twitt...
twitter.com
Women Working from
montecristomagazine.co
s - AVION
Photographs of male an...
20 Most Unprofessional Hairstyles for ...
saw a tweet saying "Google unprofessional hairstyles for work". I did. Then I checked the professional' ones
Unprofessional Work Hairstyles
What to Say When Someon...
Google search for unpr...

Problem 2

Biased Results

Knowledge search on the internet is likely biased.[2]

- Targets ~~representation~~ consumption
- Trained on ~~diverse~~ mainstream data
- Trained by ~~diverse~~ homogeneous teams
- ~~Public~~ Proprietary access
- Speed and scale doesn't help here
- Illusion of fairness

[2] Nissenbaum & Introna 2000, Vaughan & Thelwall 2004, Eubanks 2018, Selbst et al. 2019

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Knowledge is multidimensional.

- Results, even if perfectly sorted by 'relevance', may come at a cost.

[2] Nissenbaum & Introna 2000, Vaughan & Thelwall 2004, Eubanks 2018, Selbst et al. 2019

Problem 3

Choice and Accountability

- Restricts choice
  - Not easy to view the 'other side' of the spectrum
- Lacks accountability
  - Not much we can do about problematic search rankings

Problems

Taken together

Internet search $\rightarrow$ What we know, which

1. is the tip of the iceberg
2. is possibly biased
3. lacks choice and accountability

[3] Crawford 2017

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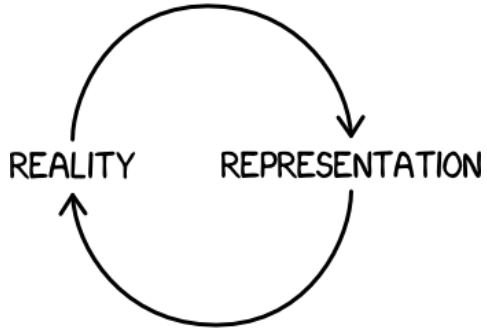

Harms of representation[3]

> *If you control the flow of information in a society, you can influence its shared sense of right and wrong, fair and unfair, real and fake, known and unknown.*
>
> *– Susskind, Future Politics (2018)*

[3] Crawford 2017

Objectives

Know how much we do not know (and its implications).

- Not a new problem

  I know that I know nothing.
  – Apology of Socrates, Plato (399 BC)

- But we have both the data and the methods now to *approximate* an answer.

Research Questions

Specifically...

For an internet search query q (say 'climate change'), along a given dimension of knowledge d (say 'sentiment'):

1. How much do we not know? (a question of *visibility*)
2. How quickly do we know more? (a question of *efficiency*)
3. What are their implications (across space and time)?

Methods

Visibility Curves

For search query q along dimension d

Visibility is the overlap in dimension d's distributions for top n vs N internet search results $(N \geq n)$.

$$K_{visibility} = \int_{R_n} min\left[f_n(d), f_N(d)\right] \, \mathrm{d}d$$

Efficiency is the scaled area under the *visibility* curve.

$$K_{efficiency} = \int_{n=1}^{N} \int_{R_n} min\left[f_n(d), f_N(d)\right] \, \mathrm{d}d \, \mathrm{d}n$$

$K_{visibility}, K_{efficiency} \in [0, 1]$ [Demo]

Developing an open-source platform

S 🎈 nder

Supported by:

- Stanford Data Science
- Digital Economy Lab, Stanford Institute for Human-Centered Artificial Intelligence (HAI)
- Stanford Center for Open and Reproducible Science
- Stanford Transforming Learning Accelerator

Visibility Curves

Metric Benefits

Visibility:

- Probability that a randomly viewed result comes from the larger population
- Distribution agnostic
- Scaled. $K_{visibility} \in [0, 1]$
- Works for both continuous and categorical dimensions

Efficiency:

- All of the above
- A single number
  - Analogous to ROC curves

Data

Data

Build a dataset of *visibility* and *efficiency* in worldwide search trends.

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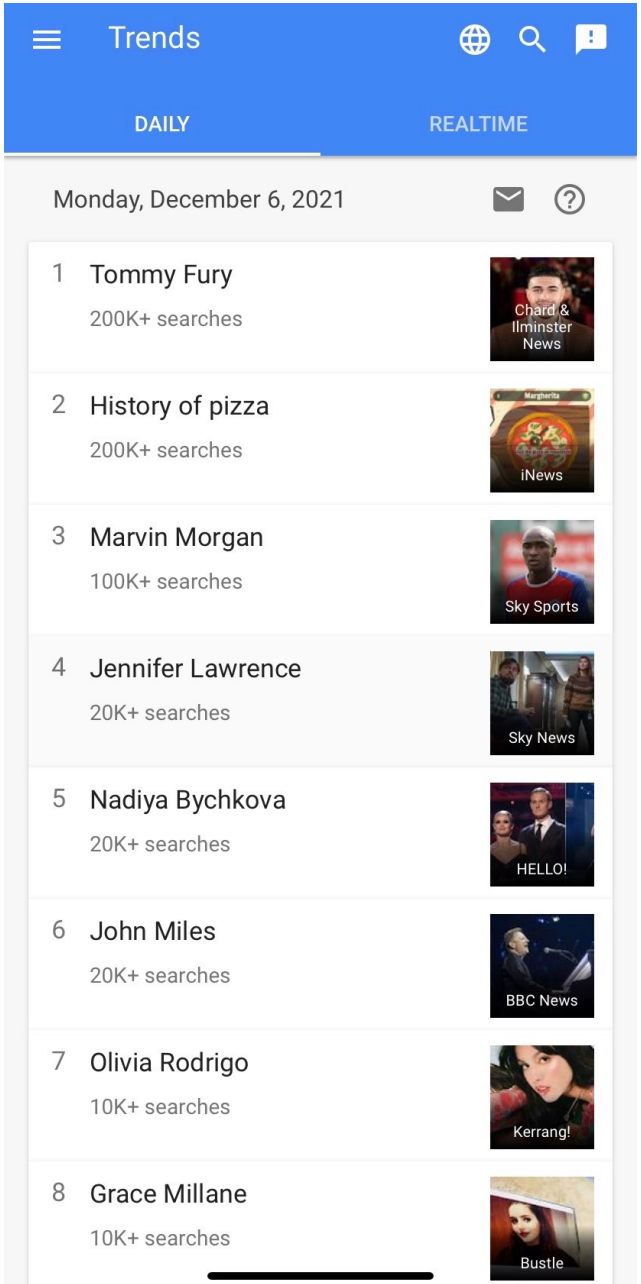


Data

Build a dataset of *visibility* and *efficiency* in worldwide search trends.

Everyday[4]:

48 nations

$\times$

20 trending queries/nation

$\times$

308 results/query[5]

$\times$

70,000 fetches/result

$\approx$

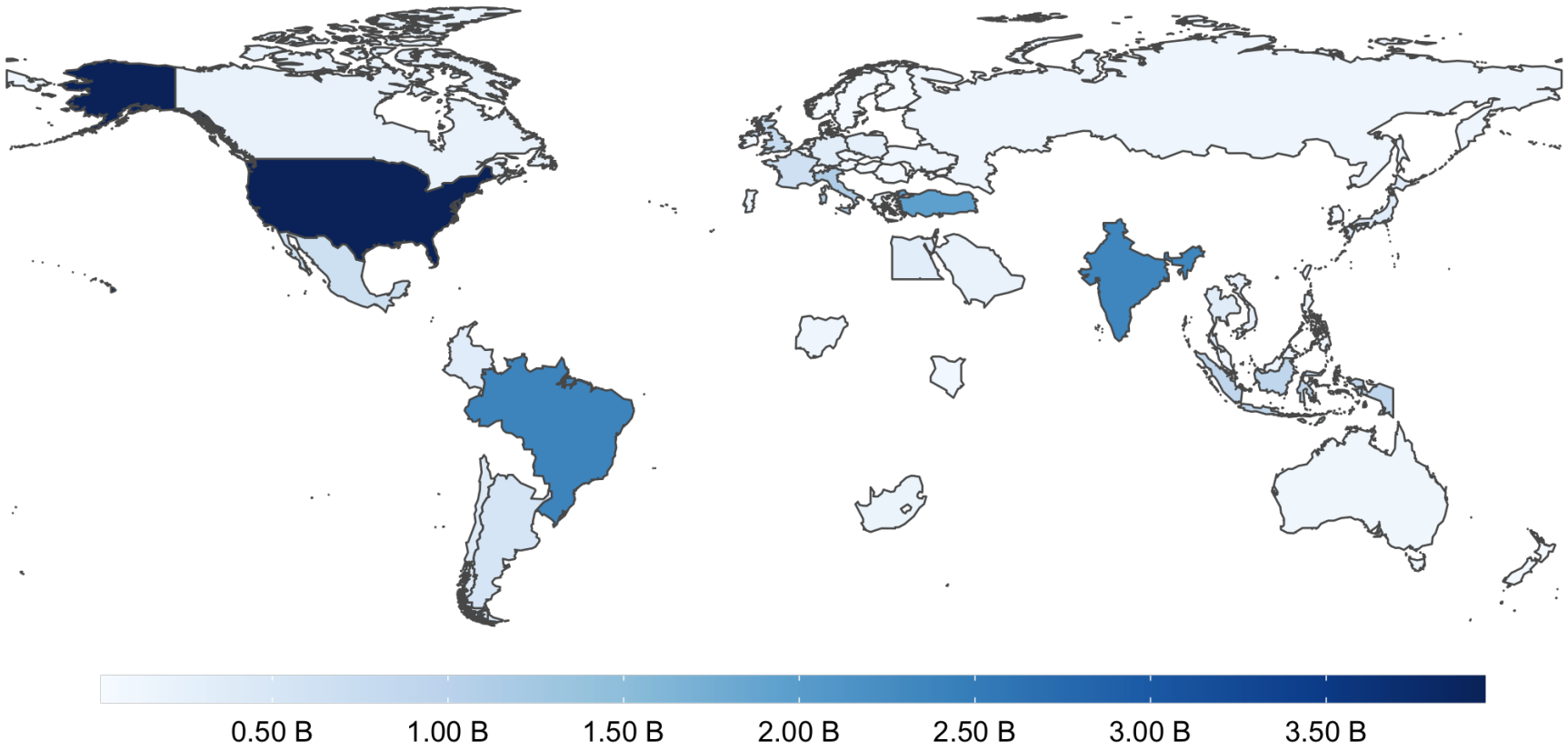
20 billion data points

[4] reporting medians

[5] Since 2016, Google caps the maximum search results shown to 300-400

Data

Daily Search Volume Fetched



Preliminary Results

[Available on request from saurabhkhanna@stanford.edu]

Reflections

Broader

- As internet search feeds us a (likely biased) tip of the iceberg, *visibility curves* can help assess how much we do not know.
- Sampling implications
  - Search results are *not* sorted by the dimension you care for.
  - Sample ~~top *n* results~~ results until a threshold visibility is reached.
- Limitations
  - Not capturing the long tail of non-trending search queries
  - Not capturing knowledge that was not indexed for web search

The way ahead

In the pipeline[6]:

1. Visibility of results from eco-friendly domains
   - 1.1 Carbon costs
2. Image search visibility
   - 2.1 Skin tone distributions
3. Press freedom
   - 3.1 Sentiment differentials between *web* and *news* trends
4. Compare search platforms
   - 4.1 Across countries
   - 4.2 Within countries [Russia]
5. Experiments [Is ignorance bliss?]
   - 5.1 Effect of knowledge visibility on tolerance and polarization

[6] 1 and 2 in active development

Thank You!

Feedback/Questions

References

- Cardoso, R. (2017). *Antitrust: Commission fines Google €2.42 billion for abusing dominance as search engine by giving illegal advantage to own comparison shopping service.* European Commission.
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