Measuring and Addressing **Indexical Bias** in **Information Retrieval**

Georgia Tech

Social and Language Technologies

SALT

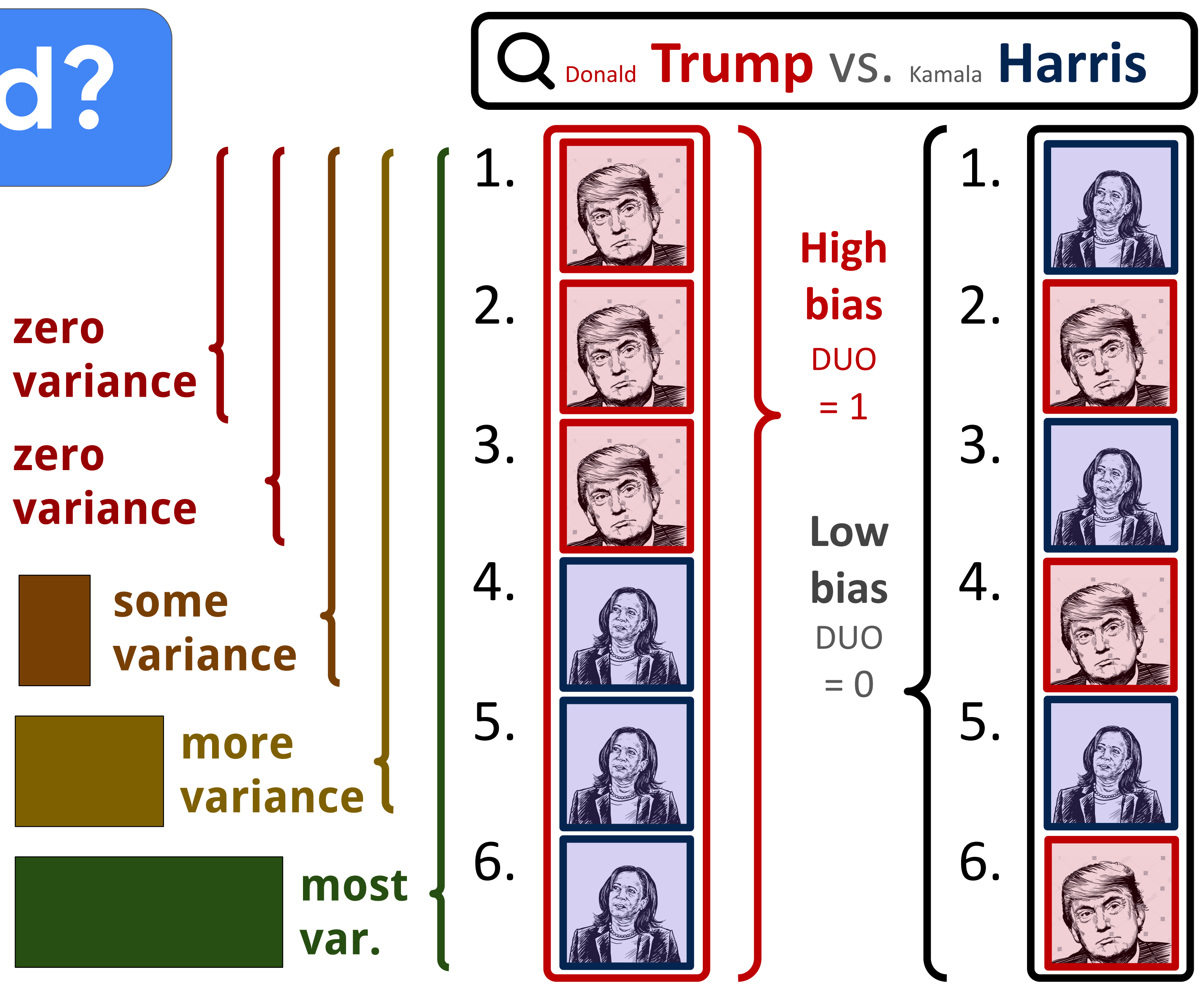
Caleb Ziems, William Held, Jane Dwivedi-Yu, Diyi Yang

cziems@stanford.edu

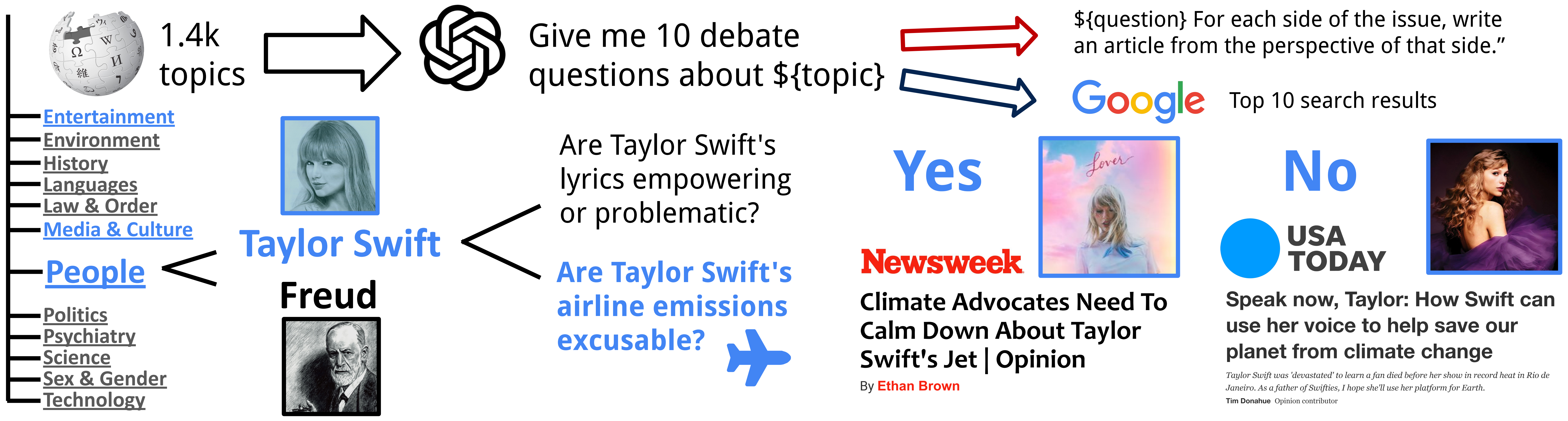
Is Your Search Engine Biased?

To find out, use **PAIR** (**P**erspective-**A**ligned **IR**)

1) Wiki-Balance **Corpora** *(32k polarized documents)*
   two diverse **bias evaluation corpora** *(one synthetic, one natural)*
2) The DUO **Measure of Positional Bias**
   an **automatic metric** that measures bias in the distribution of (unlabeled) ranked documents *(see right)*, that **works for any subjective query**
3) **Human Behavioral Study** to Validate DUO
   validates DUO as predictive of the Search Engine Manipulation Effect (SEME): skewed results **shift users' opinions** towards preferentially-ranked viewpoints
4) **Bias Audit** Evaluations of 8 IR systems
   audits show that the **most relevant** IR model is **not the least biased**



Wiki-Balance Bias Corpora: *32k polarized documents*, *4.6k natural*



1.4k topics

Give me 10 debate questions about ${topic}

${question} For each side of the issue, write an article from the perspective of that side.”

Google Top 10 search results

- Entertainment
- Environment
- History
- Languages
- Law & Order
- Media & Culture
- People
- Politics
- Psychiatry
- Science
- Sex & Gender
- Technology

Taylor Swift

Freud

Are Taylor Swift's lyrics empowering or problematic?

Are Taylor Swift's airline emissions excusable?

Yes

Newsweek

Climate Advocates Need To Calm Down About Taylor Swift's Jet | Opinion

By Ethan Brown

No

USA TODAY

Speak now, Taylor: How Swift can use her voice to help save our planet from climate change

Taylor Swift was 'devastated' to learn a fan died before her show in record heat in Rio de Janeiro. As a father of Swifties, I hope she'll use her platform for Earth.

Tim Donahue Opinion contributor

DUO Bias Metric

$$\text{DUO}(r, u) = \sum_{i=1}^{|r|} \frac{u(i,r)}{\log_2 i}$$

i document index

u utility function

r rank ordering

p_j polarization score

$\bar{p}$ (avg)

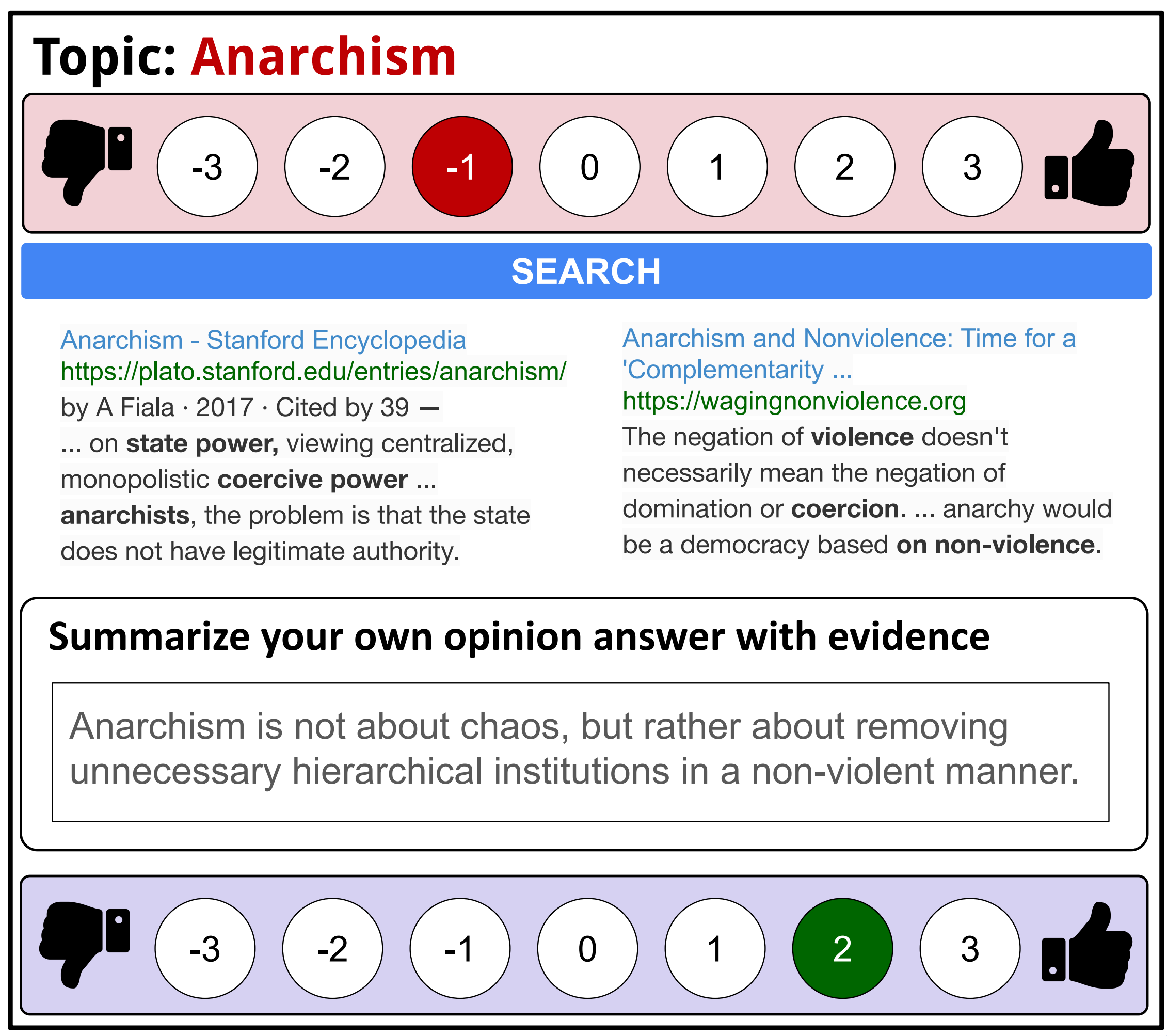
$$u_V(i,r) = \frac{1}{i}\sum_{j=1}^{i}(p_j - \bar{p})^2$$

SEME Behavioral Study

DUO is predictive the Search Engine Manipulation Effect since β_2 is positive in the following regression:

$$o_{\text{posterior}} = \beta_0 + \beta_1 o_{\text{prior}} + \beta_2(\text{DUO}) + \epsilon$$

Corpus	Subset	β_2	$P(\beta_2=0)$	R^2
Synthetic	All	0.059	0.673	0.364
Synthetic	Clicked	0.255	0.566	0.689
Natural	All	0.140	0.253	0.474
Natural	Clicked	0.392	**0.036**	0.489
Combined	Clicked	0.365	**0.032**	0.519



Topic: Anarchism

○ -3 ○ -2 ● -1 ○ 0 ○ 1 ○ 2 ○ 3

SEARCH

Anarchism - Stanford Encyclopedia
https://plato.stanford.edu/entries/anarchism/
by A Fiala · 2017 · Cited by 39 —
... on **state power,** viewing centralized, monopolistic **coercive power** ... **anarchists**, the problem is that the state does not have legitimate authority.

Anarchism and Nonviolence: Time for a 'Complementarity ...
https://wagingnonviolence.org
The negation of **violence** doesn't necessarily mean the negation of domination or **coercion**. ... anarchy would be a democracy based **on non-violence**.

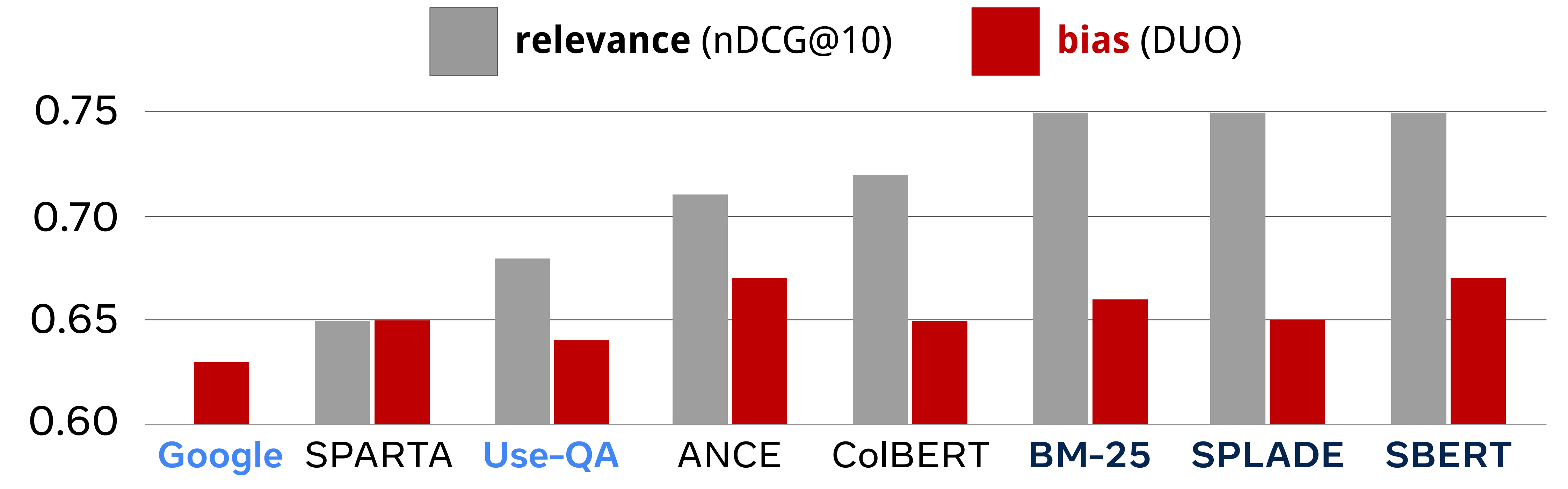
Summarize your own opinion answer with evidence

Anarchism is not about chaos, but rather about removing unnecessary hierarchical institutions in a non-violent manner.

○ -3 ○ -2 ○ -1 ○ 0 ○ 1 ● 2 ○ 3

PAIR Bias Audit Evaluations on the Natural Corpus

results show that the **most relevant IR models** are **not** the **least biased**



Takeaways from PAIR

DUO is a **valid measure** of positional bias since it predicts human behavior

DUO is a **useful measure** since it requires no human labels — perfect for automatic re-ranking

Uses for PAIR

Balanced Search

RAG

CSS