

Beyond Digital "Echo Chambers": The Role of Viewpoint Diversity in Political Discussion

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Echo Chamber

An echo chamber is an environment where a person only encounters information or opinions that reflect and reinforce their own. – The Oxford Dictionary.

Problems?

- Misinformation
- Confirmation Bias
- Bad for a healthy democracy

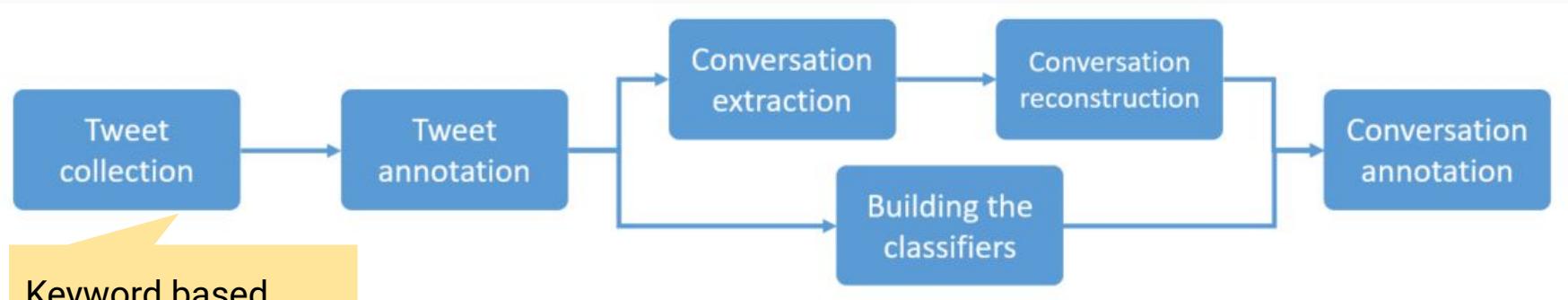
Related work

- **Deliberative democratic theory** highlights the importance of political conversations between citizens. (Cohen, 1984, Freelon et al. 2020)
- Past work focuses on studying **online conversations** using **metrics** such as **toxicity, rationality, and mutual respect**. (Mansbridge, 2015)
- **Past work** on studying echo chambers **focuses on ideological diversity**. (Bakshy et al., 2015, Barberá, 2015, Bastos et al., 2018, Cinelli et al., 2018)
- It is important to study **whether and how different viewpoints** come in **contact** with each other.
- Inspired by **viewpoint diversity metrics** conceptualized for the **news recommender systems** domain by Vrijenhoek et al. (2021).

Our Work

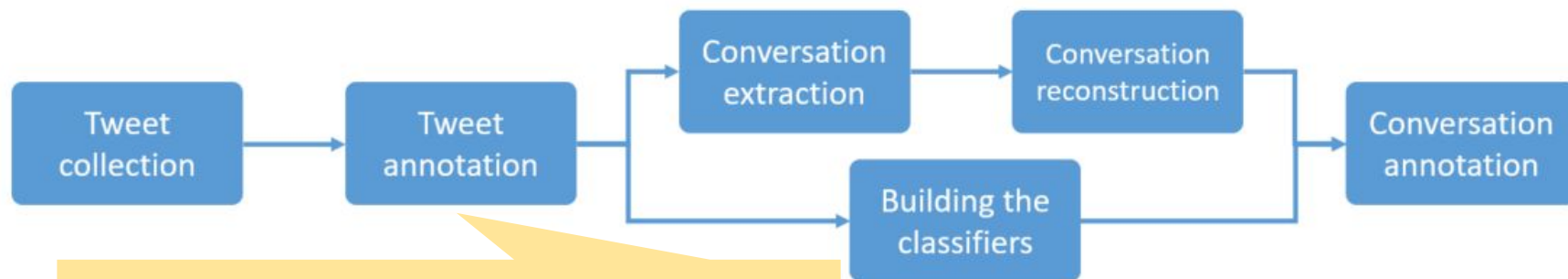
- We **propose novel operationalization** of two viewpoint diversity metrics.
 - Representation – **conversation-level** metric
 - Fragmentation – **user-level** metric
- **First study to apply the two metrics to real world data.**
- We present **in-depth analysis** of the metric behavior and discuss what it means in the **context of deliberative democratic theory**.
- We show that **echo chambers exist** for the **immigration** in the **U.S.** and control topic of Daylight Savings Time (DST).

Data Collection and Classification Pipeline

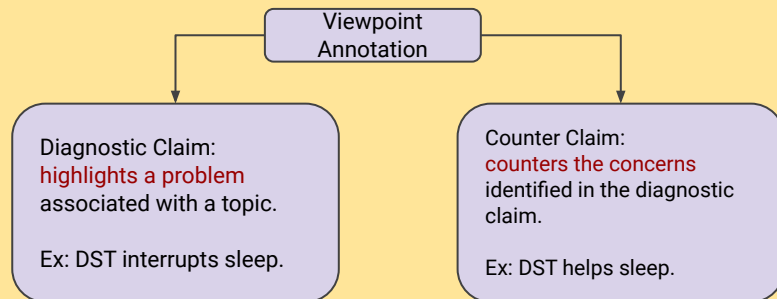


Keyword based
tweet selection →
English language
tweets → Collected
in early 2020.

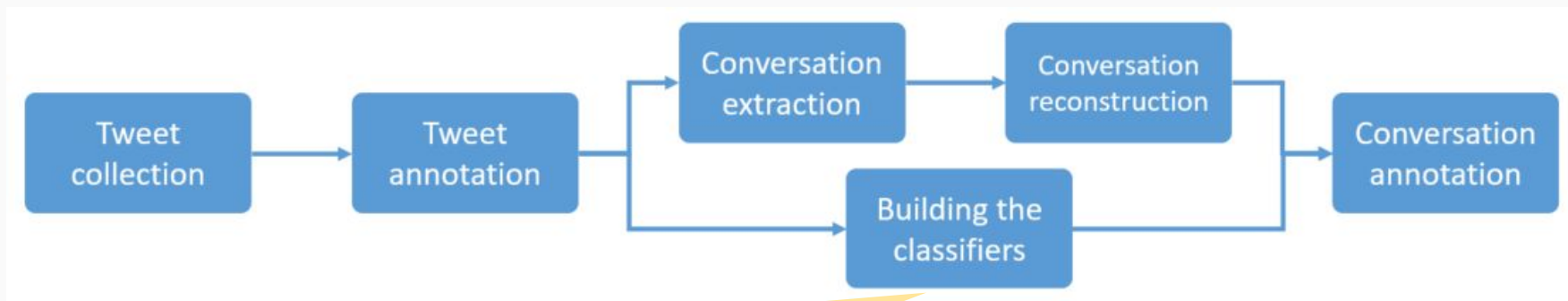
Data Collection and Classification Pipeline



Relevance annotation: Relevant, Irrelevant, Not English

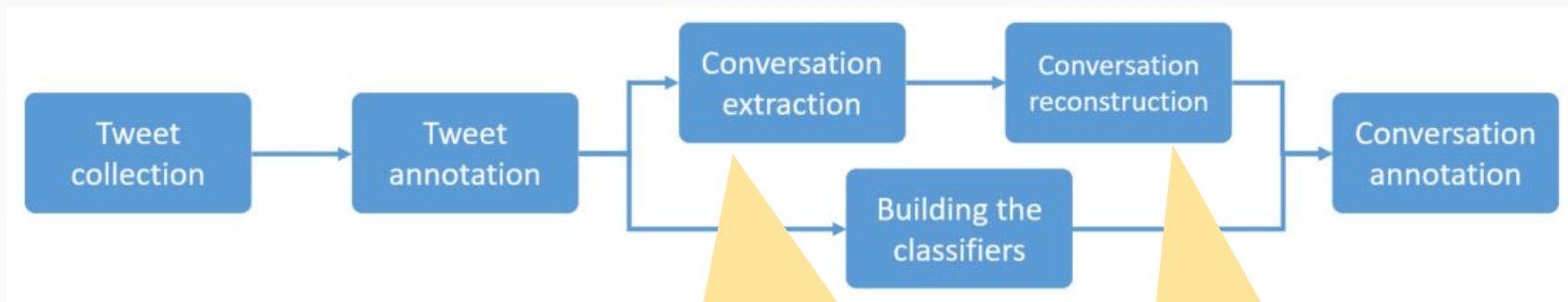


Data Collection and Classification Pipeline

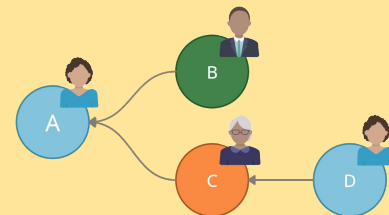


Tasks: Relevance classification, Viewpoint classification.
BERTweet: BERTweet is a large language model pre-trained on tweets.
We fine-tune BERTweet on our tasks.

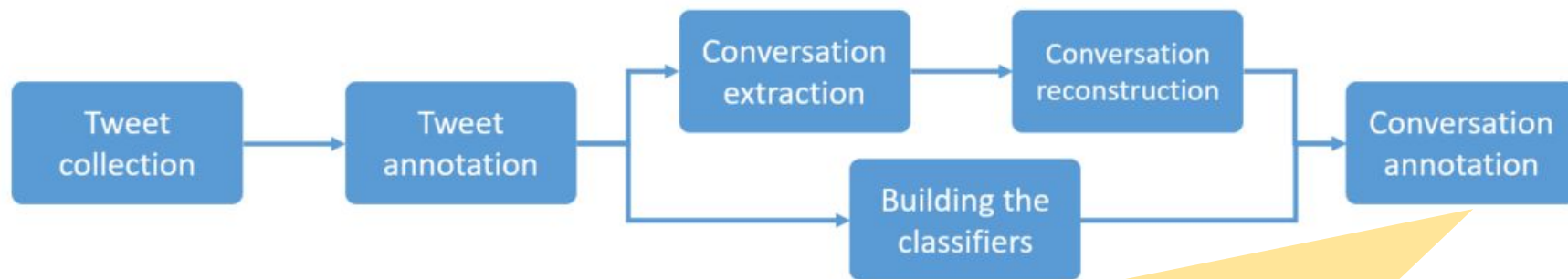
Data Collection and Classification Pipeline



We use the Academic Research Track of the Twitter API, and collect conversations of the annotated tweets.



Data Collection and Classification Pipeline



Topic	# of conversations	# of nodes	Irrelevant (L1)	No viewpoint (L2)	Diagnostic Claim (L3)	Counter Claim (L4)
DST	1756	15362	86.85%	6%	4.04%	3.1%
Immigration	404	13304	78.43%	9.86%	7.7%	4.01%

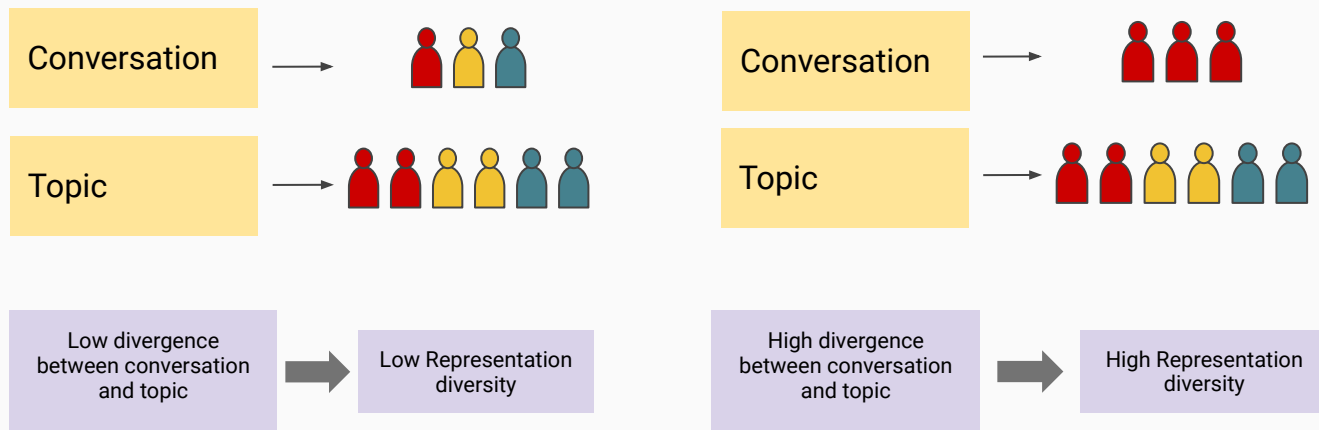
Viewpoint Diversity Metrics

Representation Diversity — Notion

Compares the views expressed in a single conversation to the breadth of views expressed for the topic overall.

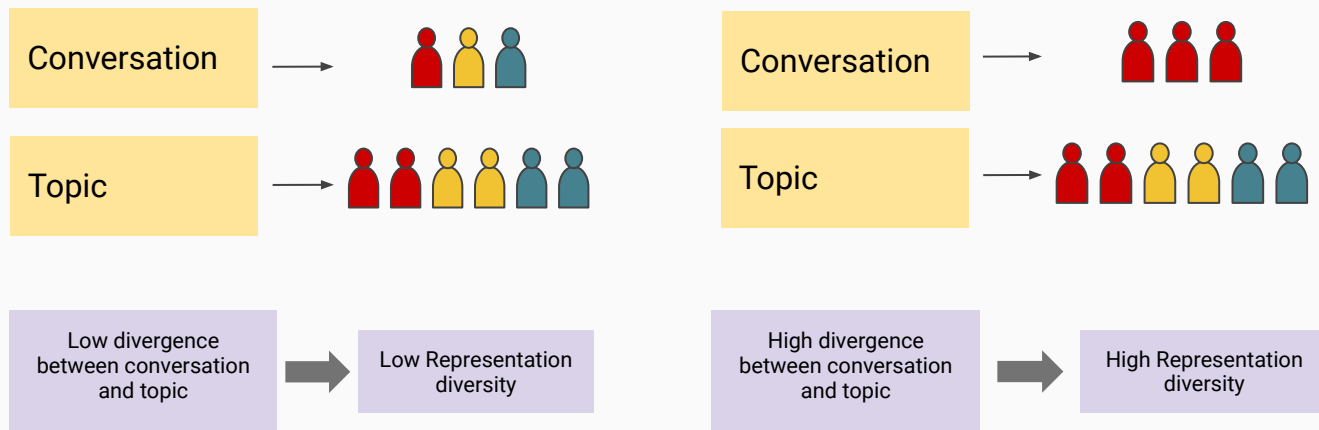
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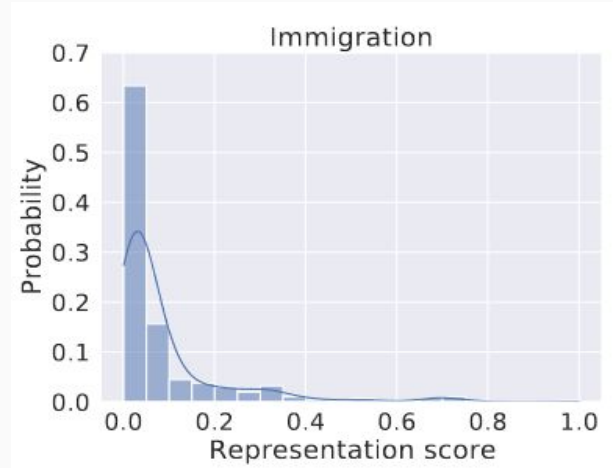
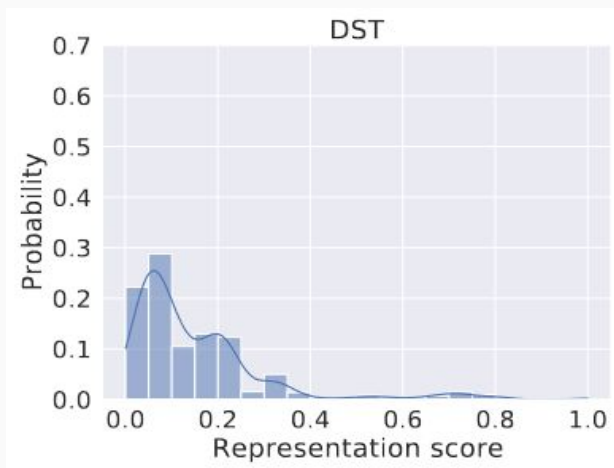
Compares the views expressed in a single conversation to the breadth of views expressed for the topic overall.



This metric aims to capture at **conversation level**, the degree to which conversations are restricted to certain views or capture the diversity of possible opinions.

Representation Diversity — Operationalization and Results

Representation diversity = **KL divergence** between the probability distribution of the viewpoint categories in a single conversation to the viewpoint distribution of the topic.



{ Representation Diversity \rightarrow 0
Representation Diversity \rightarrow 1

Discrepancy between conversation and topic is low

Discrepancy between conversation and topic is high

Fragmentation — Notion

The complement of the overlap between users' viewpoint



High overlap
between viewpoints



Low fragmentation



Low overlap
between viewpoints

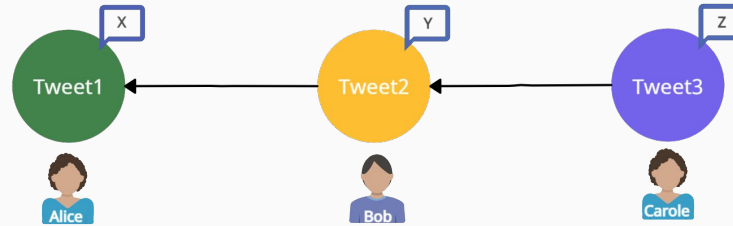


High fragmentation

This metric aims to capture at **user-level**, the extent to which individuals within a conversation are exposed to different viewpoints

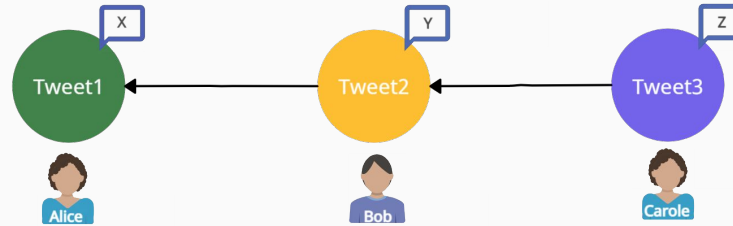
Fragmentation — Operationalisation

Conversation
network

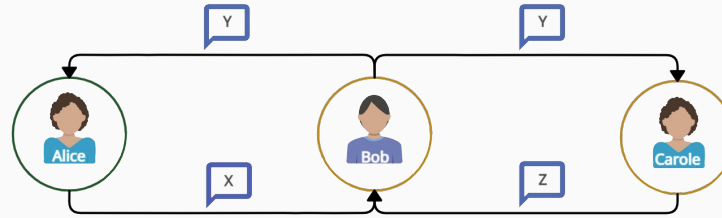


Fragmentation — Operationalisation

Conversation
network

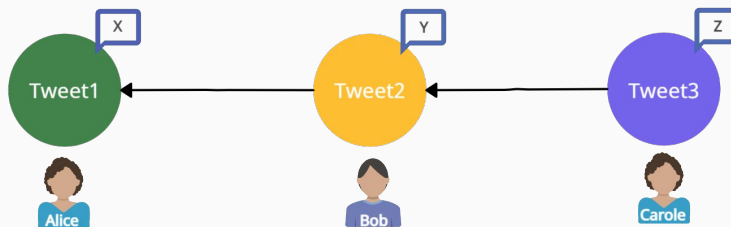


Viewpoint
network

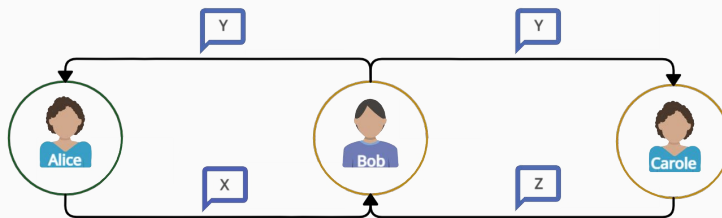


Fragmentation — Operationalisation

Conversation network



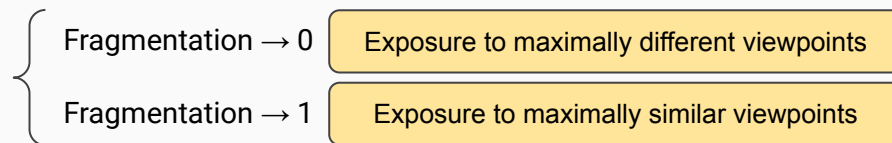
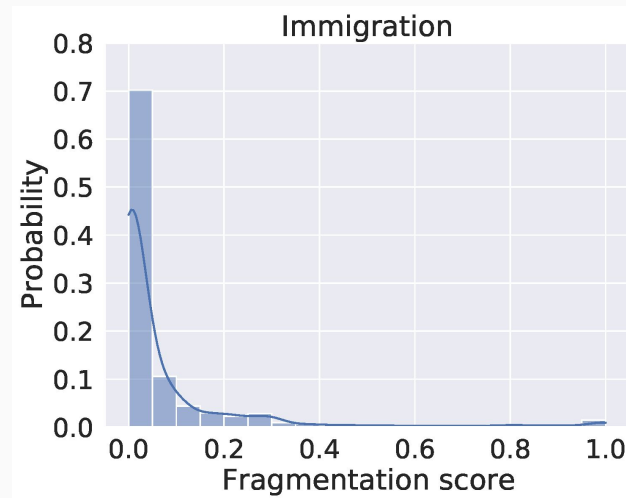
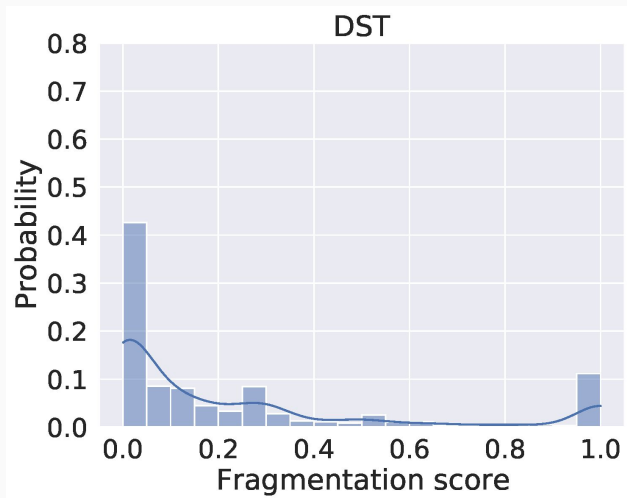
Viewpoint network



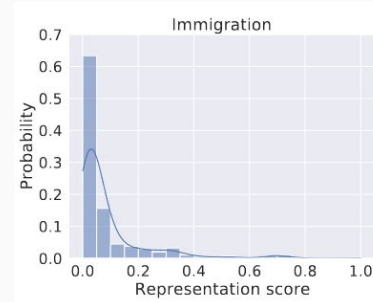
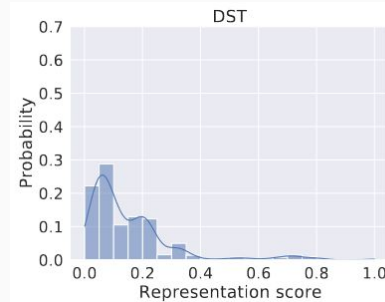
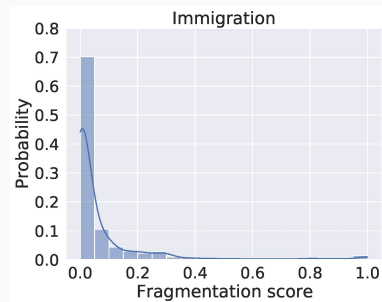
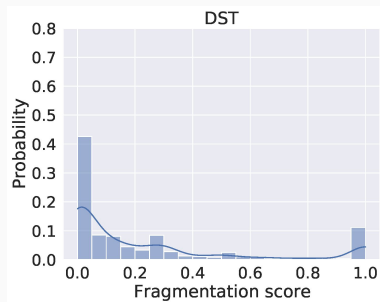
Fragmentation computation

$$\begin{array}{c} X \\ Y \\ Z \end{array} \begin{array}{c} Alice \\ Bob \\ Carole \end{array} \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix} \Rightarrow \begin{array}{l} Alice : \begin{cases} Sim(Alice, Bob) = 0 \\ Sim(Alice, Carole) = 1 \end{cases} \\ Bob : \begin{cases} Sim(Bob, Alice) = 0 \\ Sim(Bob, Carole) = 0 \end{cases} \\ Carole : \begin{cases} Sim(Carole, Alice) = 1 \\ Sim(Carole, Bob) = 0 \end{cases} \end{array} \Rightarrow \begin{array}{l} avg = 0.5 \\ avg = 0 \\ avg = 0.5 \end{array} \xRightarrow{1-avg} \begin{array}{c} Alice \\ Bob \\ Carole \end{array} \begin{bmatrix} 0.5 \\ 1 \\ 0.5 \end{bmatrix} \text{ fragmentation}$$

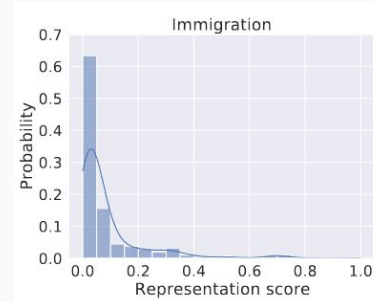
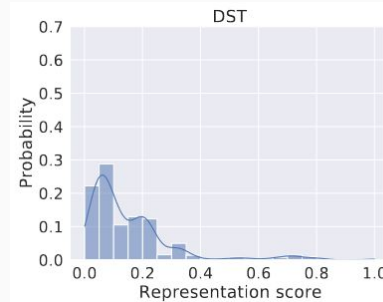
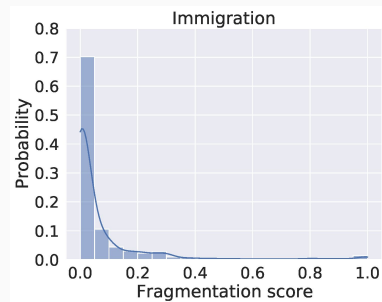
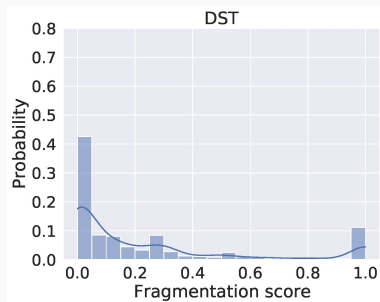
Fragmentation — Results



Fragmentation and Representation Together

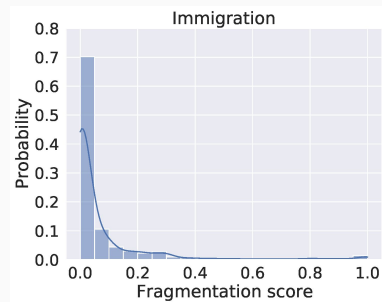
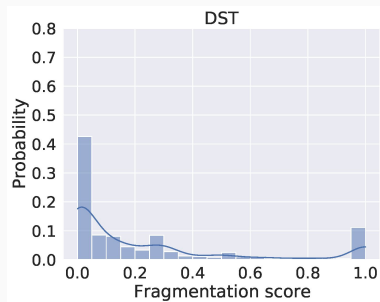


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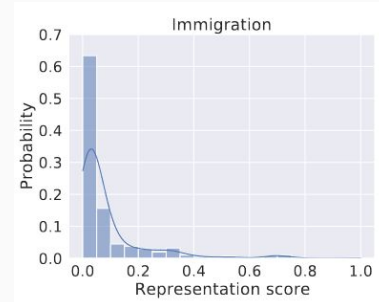
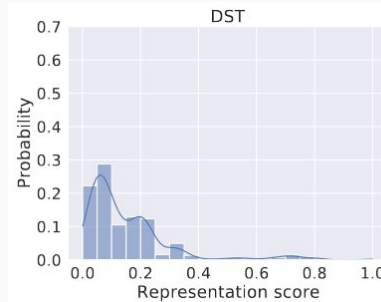


Conversations about both immigration and DST reflect the distribution of opinions in the full population

Fragmentation and Representation Together

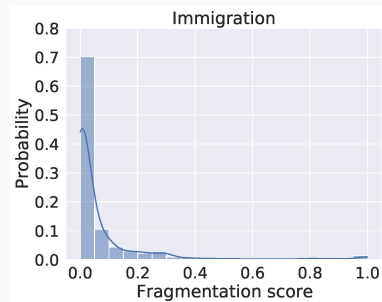
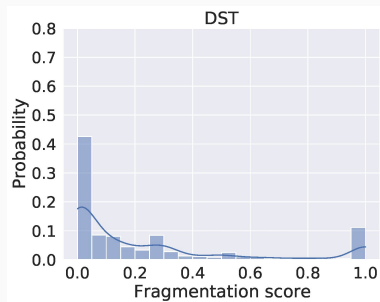


Individual users tend to have very little variability in the viewpoints to which they are exposed

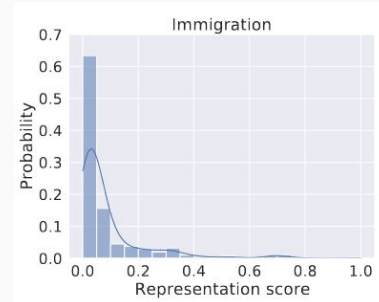
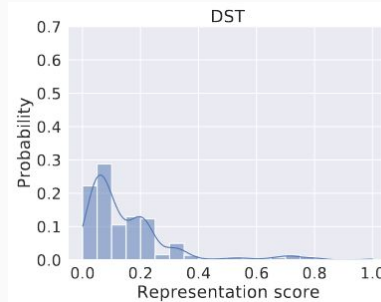


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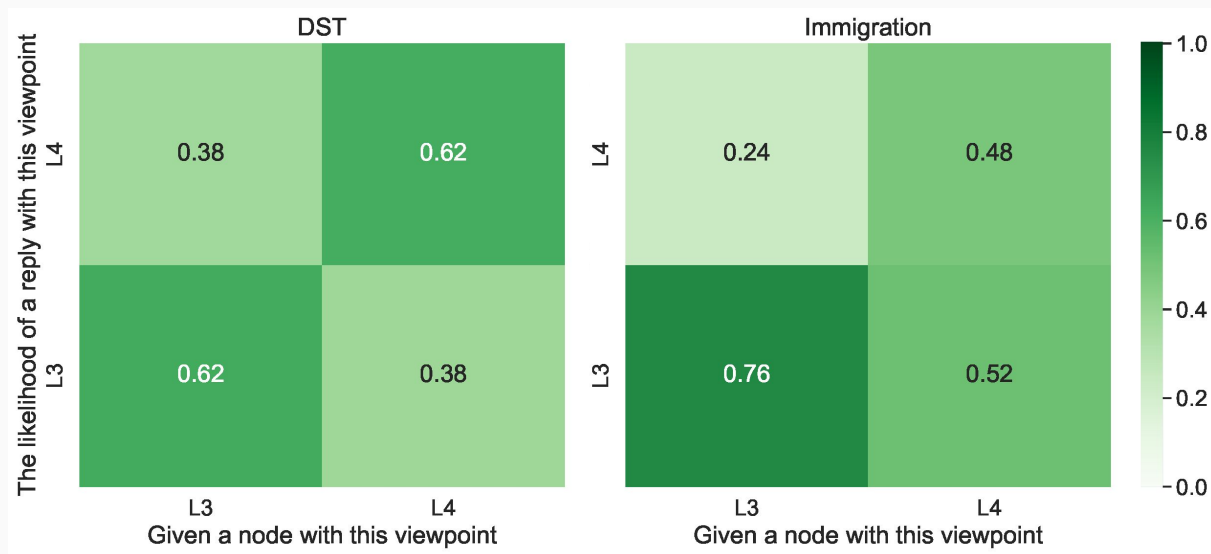
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Looking at both metrics together!

Dyadic Interaction



$P(L_n|L_m)$ where $m,n \in \{3,4\}$: the likelihood of a reply with label L_n to a tweet with label L_m

Conclusion

- Echo chambers
- Measurement of viewpoint diversity
 - Representation
 - Fragmentation
- Daylight Saving Time (DST) and Immigration
 - The diversity scores for both Fragmentation and Representation are lower for immigration than for DST
- Taken together, Representation and Fragmentation paint a meaningful and important new picture of viewpoint diversity
- Next steps
 - Expanding our dataset with even more fine-grained labels
 - Analysis of the robustness by exploring other design choices and operationalization metrics

Code and Data available at:



<https://github.com/hadarishav/beyond-digital-echo-chambers>



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