Higher-Order Estimate of Open Mindedness in Online Political Discussions

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Opinion Dynamics (OD) models study in synthetic settings how different social and psychological factors may lead to different long-term outcomes on public opinion. The current lack of data-driven approaches that validate models on real data has led us to develop a data-driven time-aware methodology[1] that estimates users' open-mindedness, starting from users' interactions represented as networks. However, in many online contexts (e.g. Reddit), people mainly participate in group discussions, which could be better captured by exploiting higher-order structures.

In the present work, we extend our previous approach[1] to hypergraphs. In order to estimate open-mindedness, we develop a simple approach that takes as input the interaction hypergraph at time t and the opinions of the users at time t and time $t+1$ (fig.1(a), upper panel). In the estimation procedure (fig.1(a), lower panel), we select each node i, and we order all the hyperedges H_j in ascending order by the average opinion distance $d_{i,H_j}(t) = |x_i(t) - \bar{x}_{H_j}(t)|$. Then, we iteratively simulate interactions between i and each hyperedge. The final estimated value $\hat{x}_i(t+1)$ is the one that minimizes the error with respect to the real value $x_i(t+1)$. Finally, we compute the confidence bound (or open-mindedness) as the distance $d_{i,H_j}(t)$ with the hyperedge representing the minimum point in the estimation errors sequence.

We applied this methodology to three different discussions on controversial topics in the American political landscape during the first two years of Trump's presidency (introduced in Morini et al.[2], where the political leaning of each user is a real value $x \in [0,1]$, aggregated by semester). We modelled such discussions both as networks and hypergraphs, to unveil the different insights that may emerge from using different underlying structures.

In fig. 1, we show the estimated open-mindedness distributions ($\widehat{CB}$) on the *political sphere* discussion, where interactions are modelled as hypergraphs (b) and as networks (c). In both settings, the temporal dynamics of open-mindedness are similar: Democrats (blue) and Moderates (green) show a more consistent level of open-mindedness over time, while Republicans (red) show a decrease in the level of open-mindedness during the first three semesters, followed by an increase in the last semester. However, when considering group interactions instead of pairwise ones, we can see that the opinion dynamics seems to be driven by a lower level of open-mindedness on average, especially when considering the Republicans subpopulation (fig. 1(b)). Preliminary analyses suggest that this phenomenon may be due to an increase in the opinion variability of the interaction contexts, which may include users that would not be considered when using networks.
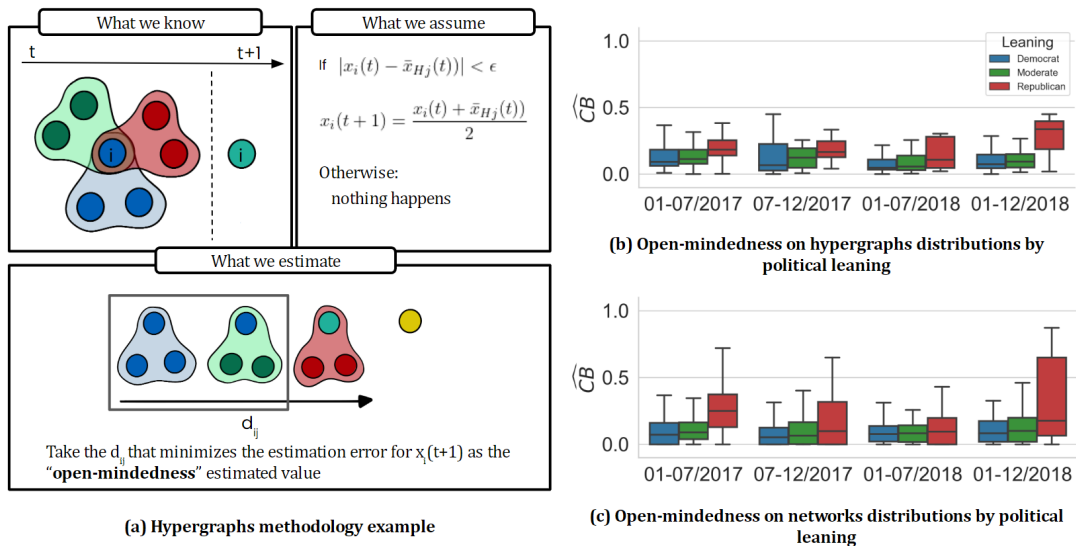

(a) Hypergraphs methodology example

(b) Open-mindedness on hypergraphs distributions by political leaning

(c) Open-mindedness on networks distributions by political leaning

Figure 1. Open-mindedness estimation on political discussions on Reddit modelled as networks and hypergraphs. Toy example of estimation methodology (a) of user u's open-mindedness at time t on hypergraphs. In panel (b) and (c) we have open-mindedness distributions on political discussions on Reddit from 01/01/2017 to 31/12/2018, by political leaning modelled as hypergraphs (b) and networks (c).

References

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