

Framework

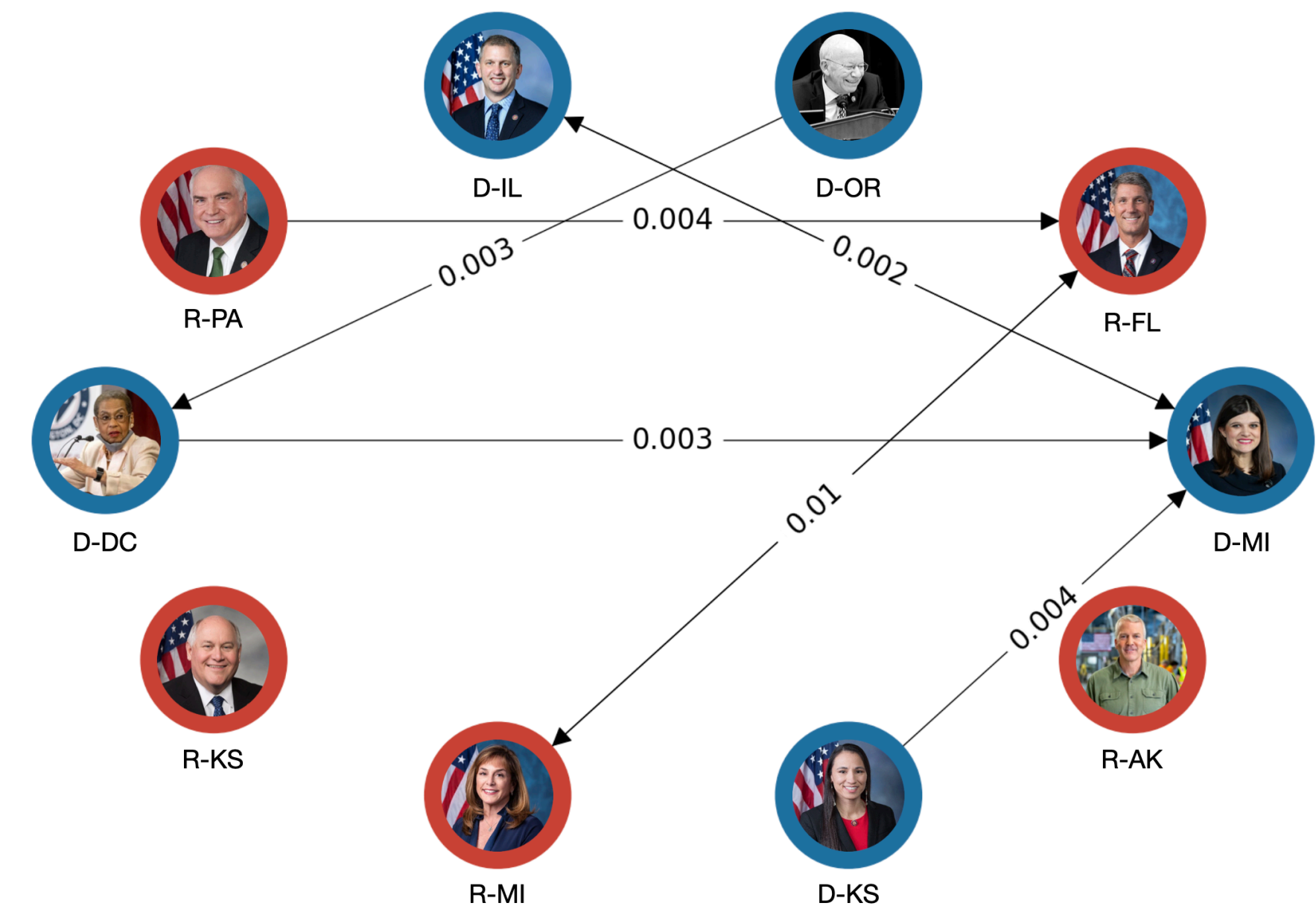
- Agents are influenced by neighbors who have opinions similar to theirs → community formation
- For graph $G = (V, E)$, the opinion dynamics are
 - $x_i(0) = x_i^0 \in (-1, 1)$
 - $x_i(t+1) = \sum_{j=1}^n p_{ij}(t) x_j(t)$
 - $\forall i, j \in V, (p_{ij}(t) \neq 0 \iff j \in \{i\} \cup N_i(t))$
 - $N_i(t) = \{j \in V \mid ((i, j) \in E) \wedge (x_i(t) - x_j(t) \leq R\rho^t)\}$
 - $R > 0$ and $\rho \in (0, 1)$ are the model parameters
- Alternatively, for $\alpha \in (0, 1/2)$ and $q_{ij} \in (0, 1)$ for all i and j , we can model

$$x_i(t+1) = \begin{cases} x_i(t) + \frac{\alpha \sum_{j \in N_i(t)} q_{ij}(x_j(t) - x_i(t))}{N_i(t)} & \text{if } N_i(t) \neq \emptyset \\ x_i(t) & \text{if } N_i(t) = \emptyset \end{cases}$$
- Given arbitrary communities $C_a, C_b \subseteq V$ and opinions x_i^* , we define pairwise community opinion disparity

$$\psi_{ab} = \psi_{ba} = \left| \frac{1}{C_a} \sum_{i \in C_a} x_i^* - \frac{1}{C_b} \sum_{i \in C_b} x_i^* \right|$$

Data

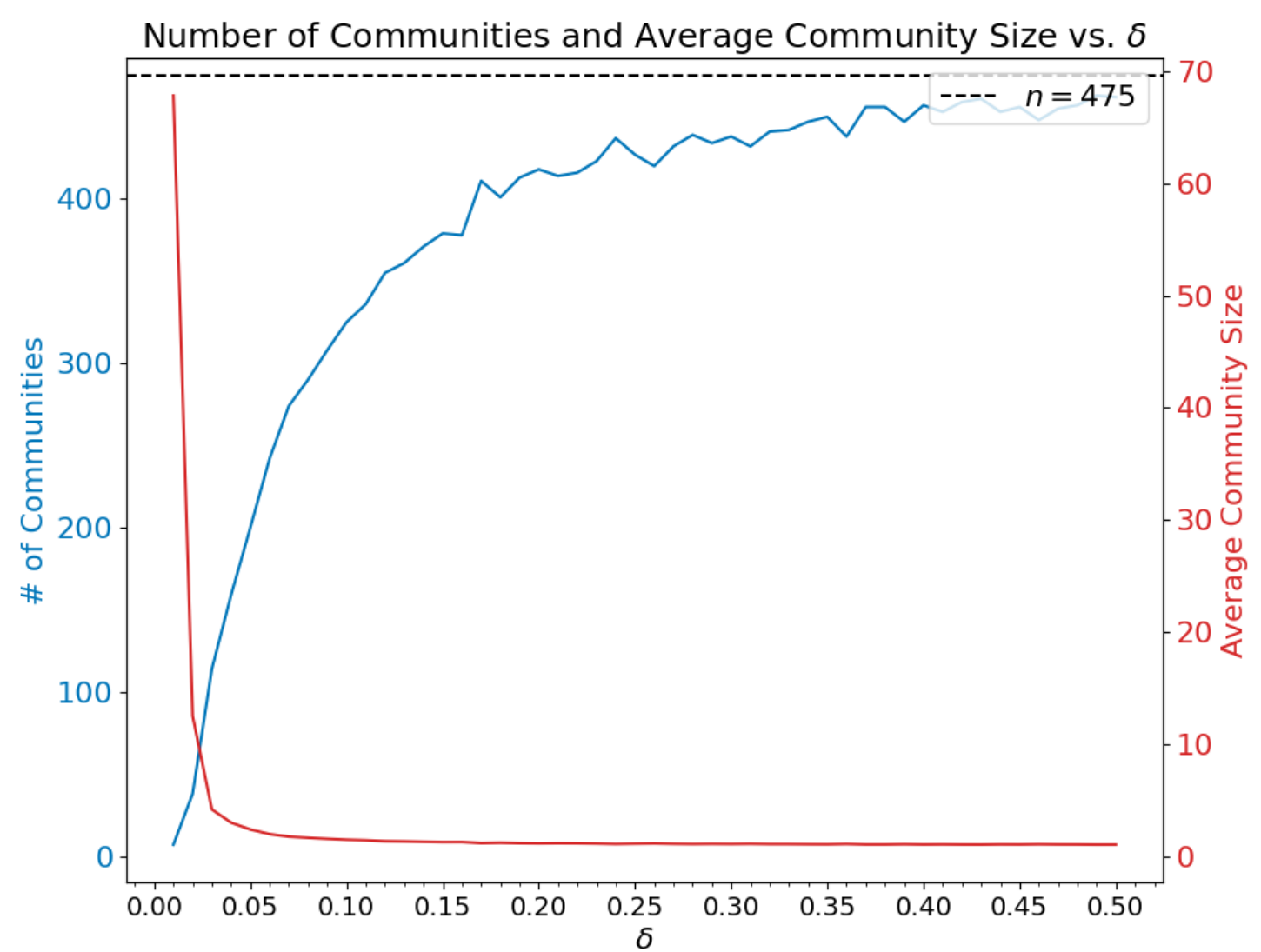
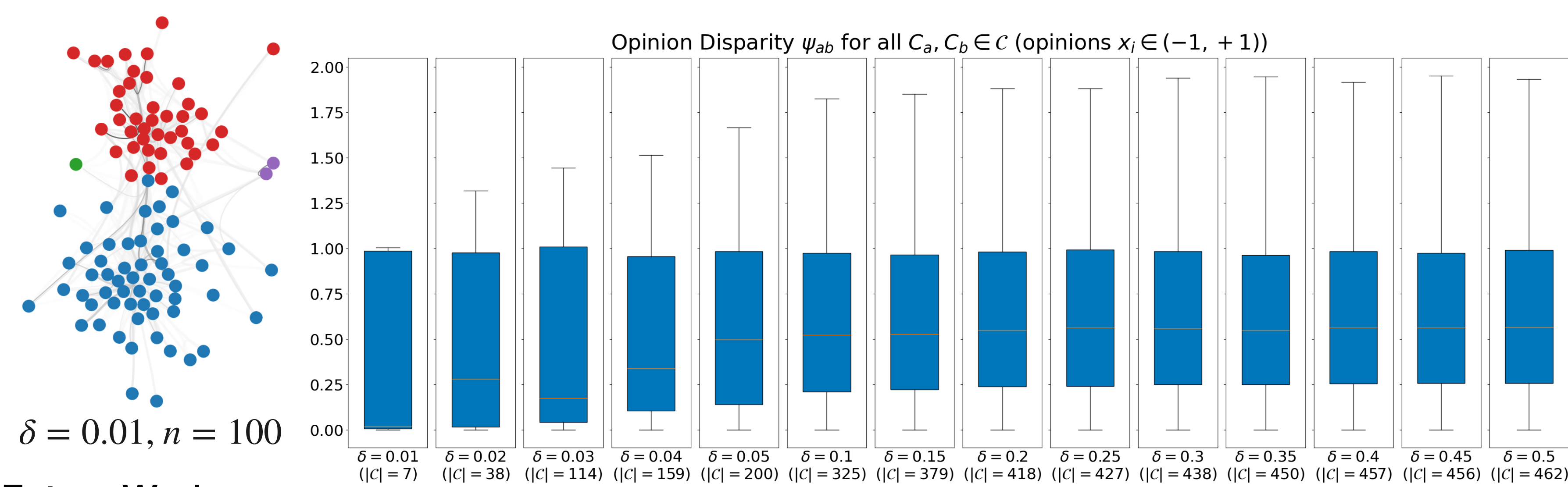
- Twitter dataset based on interactions between members of the 117th United States Congress between Feb. 9th, 2022 and June 9th, 2022 ($V = 475$, $E = 13289$)
- Directed, weighted network in which edge weights are empirically obtained “probabilities of influence” between all pairs of congresspeople
 - Probabilities are based on how many times the congresspeople retweeted, quoted, replied to, or mentioned other congresspeople



Randomly sampled congresspeople ($n = 10$)

Results

- Changing the way in which edges are represented leads to different outcomes → implement two models
 - Model 1:** $p_{ij} = 1 \iff ((i, j) \in E) \vee ((j, i) \in E)$ (undirected, unweighted edge)
 - Model 2:** p_{ij} is a normalized probability of influence of congressperson i on congressperson j (directed, weighted edges)
- An optimal solution (Morărescu et al.) is $\rho = 1 - \alpha\delta$, which we used in **Model 2** above
- We opted for $x_i^0 \sim \text{Uniform}(1,0)$ if congressperson i is a Democrat, $x_i^0 \sim \text{Uniform}(-1,0)$ if congressperson i is a Republican, and $x_i^0 \sim \text{Uniform}(-1,1)$ otherwise (directionality arbitrarily chosen)



Future Work

- As opinions flow through the network, the probabilities of influence change, which lends itself to an adaptive weighting scheme
- Different opinion initializations likely lead to different outcomes → can we assume a normal distribution over the opinion space?
- We currently generate opinion values for congresspeople based on political party affiliation
 - A more precise way to generate these values could be to conduct sentiment analysis on the tweets from congresspeople