# Interactions of the Twitter 'Elite':
## Clustering Celebrities, Media Outlets, and Politicians

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## Motivation

- Social media increasingly influences real-world events.
- Some suggest that distinctions between celebrities, media outlets, and politicians have become blurred.
- Twitter provides publicly available interactions between hundreds of millions of active users.
  - We can study how these three groups relate to each other and how distinct they are in terms of online interactions.

## Background

- Among multiple user types, information spreads homogeneously [4].
  - On Twitter, URLs tend to travel between members of the same groups.
  - Study included celebrities, media outlets, blogs, and organizations.
- Overlap of user types' roles in the real world.
  - Politicians and celebrities' roles have become intertwined [3].
  - High-profile "opinion leaders" act as a bridge between media outlets and the general public [1].
- Community Detection within Networks [2].
  - Spectral clustering uses an affinity matrix to cluster nodes in high-dimensional, non-Euclidean spaces.

## Questions of Interest

- Can we distinguish between categories of highly-visible users based on their interactions with each other?
  - Possible categories: celebrity, media outlet, politician.
  - Define "Highly-visible" users as the users with the highest number of followers.
- Which types of users interact the most with each other?
  - How does this differ across different types of interactions?

## Acknowledgments

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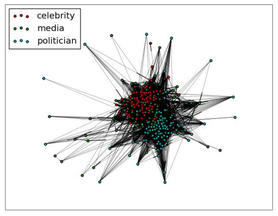
## Approach

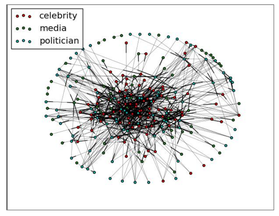
- Create interaction networks between celebrities, media outlets, and politicians with the highest number of followers (100 of each).
  - Create a separate network for each type of interaction: mentions, retweets, and replies.
- Use network metrics to measure mixing between user types.
- Cluster nodes according to interactions.
- Evaluate clustering based on strength of clusters and how well clusters capture user type labels.

## Interaction Networks

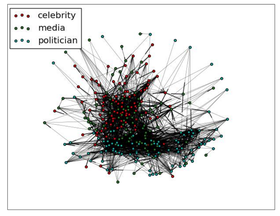
- **Mentions**: the source user links to the target user in a Tweet.
- **Replies**: the source user replies to one of the target user's Tweets.
- **Retweets**: the source user re-posts one of the target user's Tweets.




Mentions Network



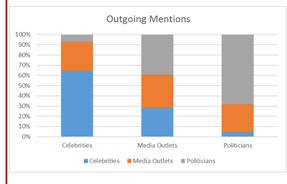

Replies Network

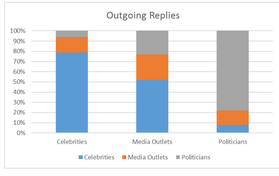


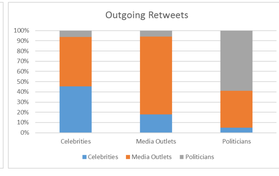

Retweets Network

## Network Metrics

- Mixing, separated by user type: mainly homogeneous for celebrities and politicians, more heterogeneous for media outlets.




- Mixing for each type of network.
  - Attribute assortativity coefficient measures amount of mixing between different types of users. Value of 1 indicates perfect homogeneity, 0 indicates random distribution of interactions between user types.

| Interaction Type | Attribute Assortativity Coefficient |
|---|---|
| Mentions | 0.28 |
| Replies | 0.55 |
| Retweets | 0.32 |

## Clustering

- We use $A + A^{\top}$ symmetrization of the network adjacency matrix as the affinity matrix used for Spectral Clustering.
  - Network adjacency matrix: $A_{\{ij\}} = 1$ if user *i* initiates an interaction with user *j*.
  - Chosen based on lowest conductance score after testing various symmetrization methods (bibliometric, degree-discounted, undirected adjacency matrix).
- Spectral Clustering projects affinity matrix to lower-rank matrix and performs k-means clustering on projection.

## Cluster Evaluation

- Evaluation Metrics
  - Conductance: strength of separation between clusters (0 indicates no crossing edges between clusters, 1 indicates that all edges from nodes in one cluster go to nodes in another cluster).
  - Homogeneity: how well clusters separate members of different categories.
  - Completeness: how well clusters group members of the same category.
  - V-measure: metric that balances homogeneity and completeness.
- For comparison, also evaluated clusters produced using adjacency matrix of undirected interaction graph as the affinity matrix for spectral clustering.

| | $A + A^{\top}$ | | | Adjacency Matrix of Undirected Graph | | |
|---|---|---|---|---|---|---|
| | Mentions | Replies | Retweets | Mentions | Replies | Retweets |
| Conductance | 0.295 | 0.153 | 0.114 | 0.658 | 0.608 | 0.662 |
| Homogeneity | 0.381 | 0.356 | 0.015 | 0.004 | 0.015 | 0.035 |
| Completeness | 0.398 | 0.410 | 0.017 | 0.004 | 0.017 | 0.035 |
| V-measure | 0.389 | 0.015 | 0.016 | 0.004 | 0.016 | 0.035 |

## References

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