Lower-Order and Higher-Order Centrality Correlations in Real-World Networks

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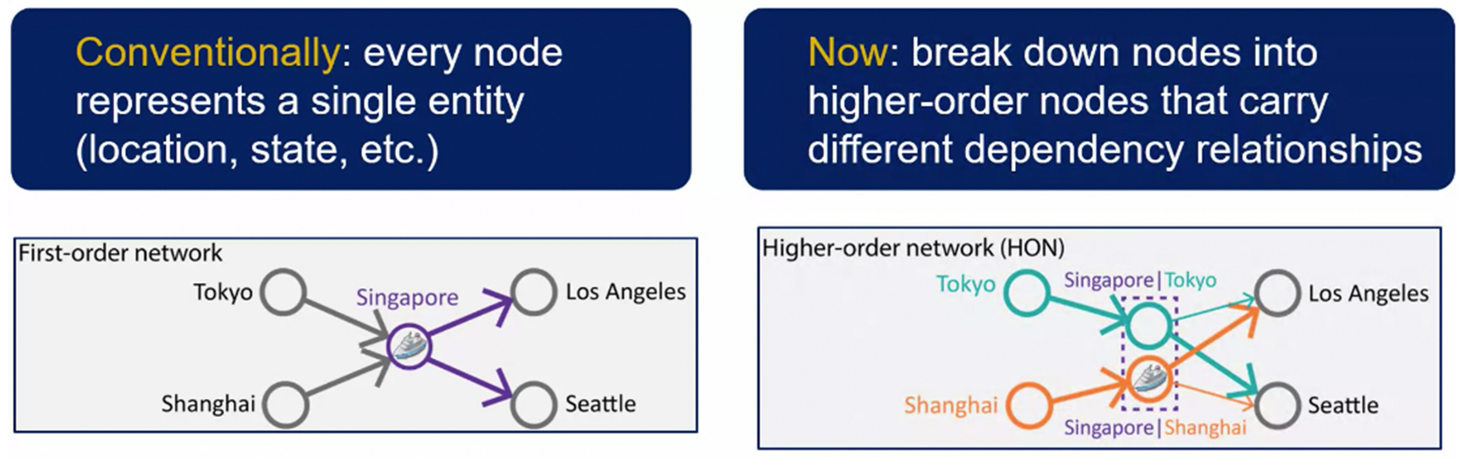
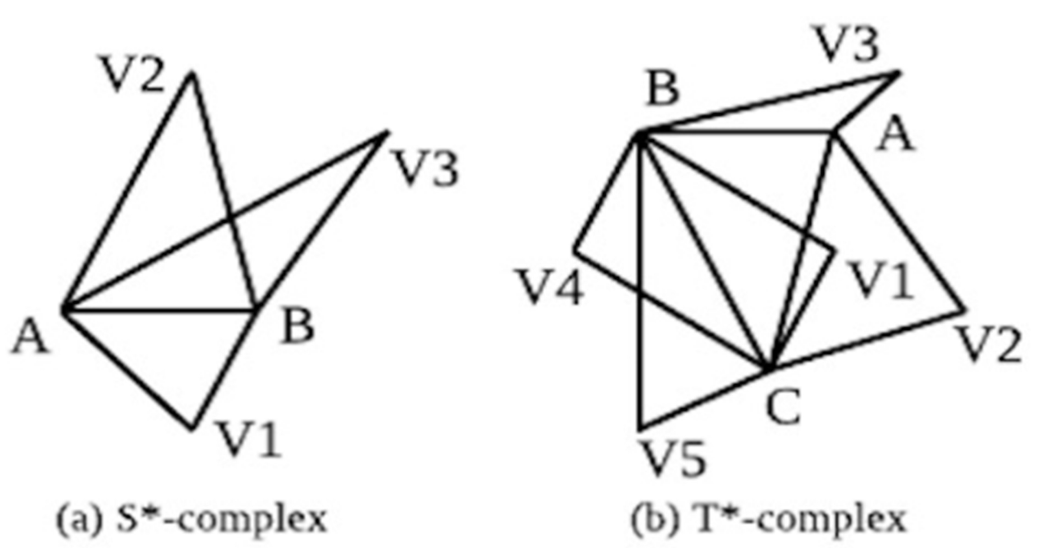
Introduction

- Early network science research focused on **lower-order networks** (ex.: dyadic edges) [1], but lower-order networks are limited in complex analyses
- **Higher-order structures** increasingly recognized in network science research as central features of **real-world communication networks** [1]
- Models allowing higher-order interactions preserve and illuminate dependencies in the lower-order network, leading to more accurate network analysis [3]



Xu et al., 2022

- **Simplicial complexes** are a specific class of higher-order structures gaining traction in the field of network science [2]
- Found in several other models (social contagion, transportation) but little known of its application to real-world communication networks [1, 2]



(a) S*-complex (b) T*-complex

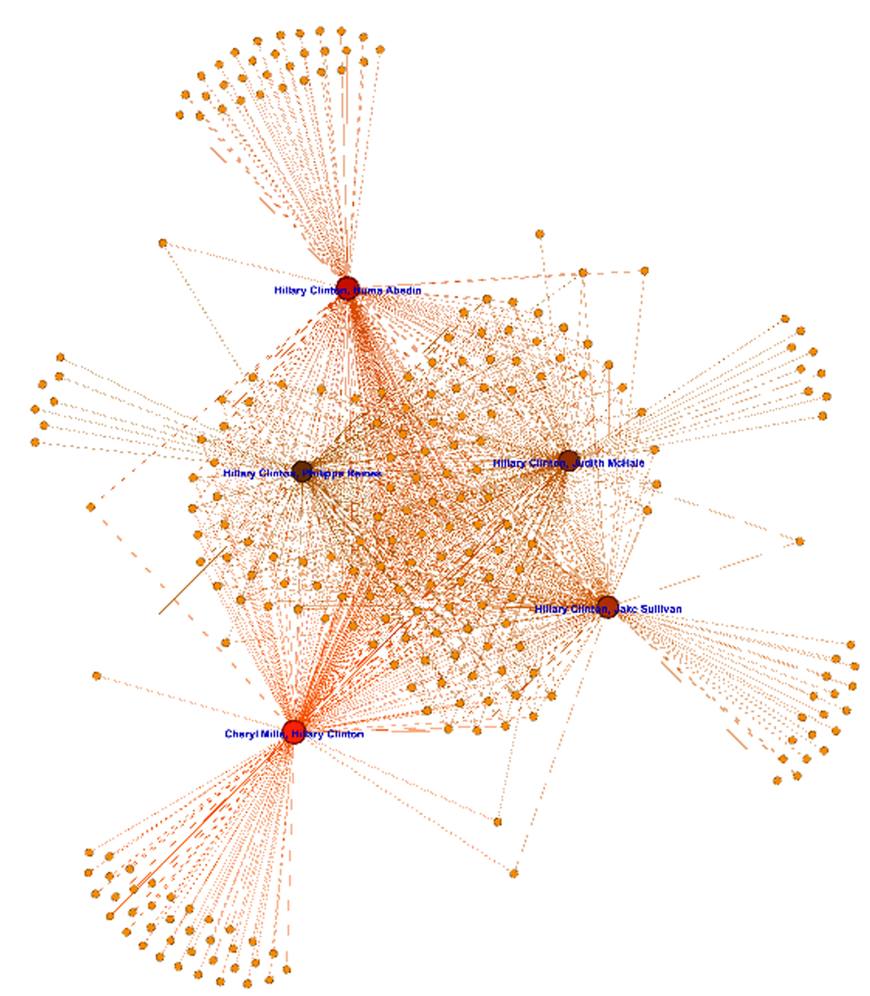
Kejriwal and Shen, 2022

- Do higher-order centrality calculations correlate with their corresponding lower-order centralities in real-world networks?
- Do different types of centralities affect the correlations between the lower-order nodes and their respective higher-order lines?

Methods & Results

RQ: What is the relationship between the higher-order and lower-order centrality in real-world networks?

- Conducted **4 experiments** on higher-order line network extracted from Hillary Clinton emails network (192 nodes and 277 edges)
- Each experiment under 1 of 4 types of centrality: **betweenness, degree, closeness, and eigenvector**
- Examined against 2 lower-order centralities: sum and average of corresponding lower-order nodes

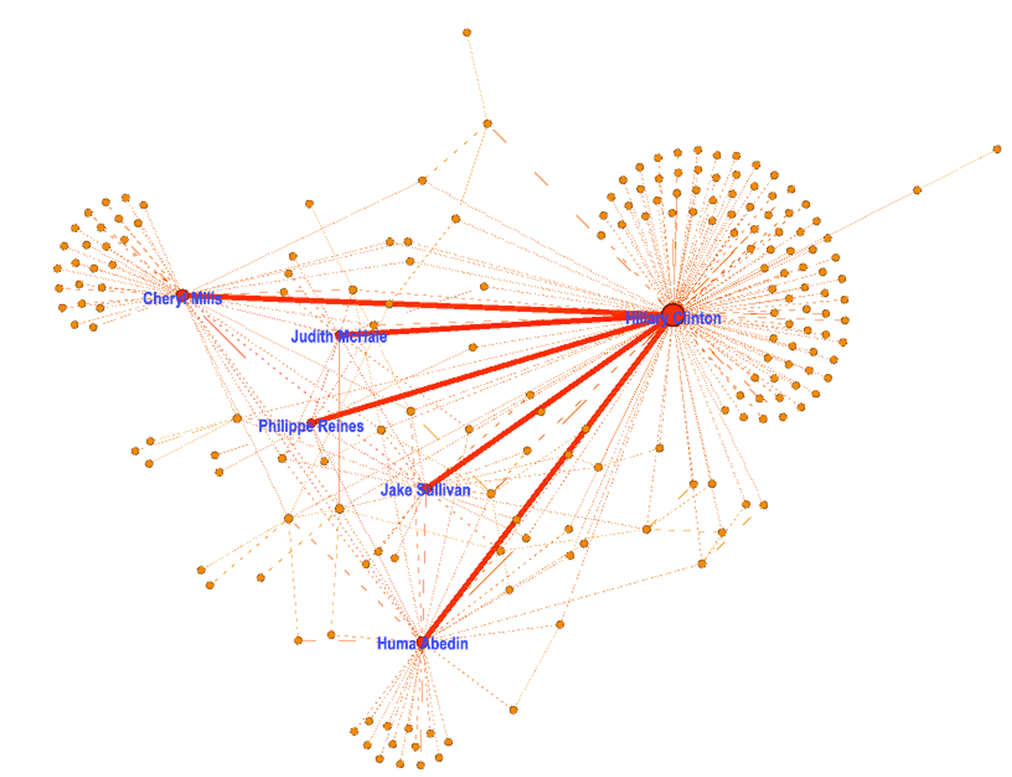


- Calculated **Pearson correlations** using lower-order sum and average centrality and higher-order centrality per line in higher-order network
- Degree centrality exhibited highest positive correlation, with other centrality types exhibiting less strong yet significantly positive correlations
- No difference between correlations against sum or average

Clinton Emails Dataset			
	Pearson Correlation		
Centrality Type	**Sum**	**Average**	**P-value**
Betweenness	0.41	0.41	0.07
Degree	1	1	0
Closeness	0.86	0.86	9.01E-07
Eigenvector	0.94	0.94	5.02E-10

Future Work

- 3-way centrality correlation analysis between lower-order, line, and triangle networks
- Is the node-triangle direct representation more accurate than the node-line-triangle representation?
- Constructing second-order triangle network from real-world networks to continue centrality correlation analysis against various lower orders



References

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[2] Iacopini, I.; Petri, G.; Barrat, A.; and Latora, V. 2019. Simplicial models of social contagion. Nature communications, 10(1): 1–9.

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