Universität Zürich[UZH]

UZH Blockchain Center

Blockchain & DLT Research Group

Network Science HS24

Assignment 3

Blockchain & Distributed Ledger Technologies Group

FOR STUDIES PURPOSES ONLY

UZH Blockchain Center
Faculty of Business, Economics and Informatics
University of Zurich
Zurich, October 7, 2024

Centralities (6 points)

For the provided datasets (you can find the dataset files in the Assignment folder on Teams):

1. (1 points) Compute degree, closeness, betweenness and eigenvector centrality for each node. Plot the distribution for each of the centralities, paying attention to binning.

2. (2 points) Do a scatter plot of each pair of centralities (6 plots total). Compute the Pearson, Spearman and Kendall correlation coefficient for each pair and note them on the scatter plots. *Hint: centrality measures are available in `NetworkX`, while correlation coefficients are available in the module `scipy.stats`.*

   For 2 vectors $\mathbf{x}$ and $\mathbf{y}$, the Pearson's r correlation is:

   $$r(\mathbf{x}, \mathbf{y}) = \frac{Cov(\mathbf{x}, \mathbf{y})}{\sigma_{\mathbf{x}} \sigma_{\mathbf{y}}},$$

   The spearman's ρ is:

   $$\rho(\mathbf{x}, \mathbf{y}) = r(rank(\mathbf{x}), rank(\mathbf{y})),$$

   where $rank(\mathbf{x})$ is the sorted version of $\mathbf{x}$. Kendall's τ is:

   $$\tau(\mathbf{x}, \mathbf{y}) = \frac{1}{\binom{N}{2}} \sum_{i>j} sign(x_i - x_j) sign(y_i - y_j),$$

   where $sign(z)$ is 1 if $z > 0$, -1 if $z < 0$, and 0 if $z = 0$.

3. (2 points) Randomise the given networks and calculate the same centralities as in 1. Create a scatter plot of the original centralities and the randomised ones, compute the Pearson correlation coefficient for each pair and note them on the scatter plot. Briefly comment on what you have observed. *Hint: to generate randomised graphs you can use `Networkx`, as you did in assignment 2.*

4. (1 point) Provide an interpretation of each centrality, rooting it in the results you computed in the previous points and the real-world relations the networks are describing. Explain the interpretation of each centrality and the observed differences and similarities reported in the previous points.

Datasets provided

- European airline network: Nodes represent airlines and Edges represent airline routes among European airports, Cardillo et al. [2013].
- Jazz collaboration network: Nodes represent jazz musicians and Edges represent collaborations in bands that performed between 1912 and 1940, Gleiser and Danon [2003].
- Game of Thrones co-appearances: Nodes represent Game of Thrones characters and Edges represent co-appearances of characters in the Game of Thrones series, Beveridge and Shan [2016].

References

Beveridge, A. and Shan, J. [2016]. Network of thrones, *Math Horizons* **23**(4): 18–22.

Cardillo, A., Gómez-Gardenes, J., Zanin, M., Romance, M., Papo, D., del Pozo, F. and Boccaletti, S. [2013]. Emergence of network features from multiplexity, *Scientific Reports* **3**: Article number: 1344.

Gleiser, P. M. and Danon, L. [2003]. Community structure in jazz, *Advances in complex systems* **6**(04): 565–573.