A06: Inference of Networks

Network Science '21: Assignment 6

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Objectives

1. Learn how to fit and generate networks from ERGM configuration models
2. Explore null models for a real economic network
3. Perform inferences about the system

A06.1 Exponential Random Graph Models

A06.1 - Exponential Random Graph Models

> **Task:** *For the World Trade Web dataset, fit different ERGM-based Configuration Models and compare basic network metrics with null models*

For each of the WTW networks provided:

+ measure the average clustering and reciprocity coefficients
+ fit the Undirected Binary CM and Directed Binary CM
+ sample 10 networks from the obtained distributions and measure clustering and reciprocity (for the Directed ones)
+ plot clustering and reciprocity as functions of time, comparing the real value with the average from the sampled networks

A06.2 - Weighted ERGMs

Task: *Repeat the analysis of point 1 with weighted networks*

+ measure strength assortativity coefficient on the data
+ fit the Undirected Enhanced CM and Directed Enhanced CM using the CReMa method
+ sample 10 networks from the obtained distributions and measure strength assortativity
+ plot strength assortativity as a function of time, comparing the real value with the average from the sampled networks
+ in the directed case, plot all pairs of assortativity (in-in, in-out, out-out)

A06.3 - Drawing conclusions

Task: *write a short paragraph to draw conclusions about the structure of the World Trade Web based on the ERGM inferential approach*

You should include at least the following points:

+ Comment on the interpretation of the clustering and reciprocity coefficients found in the original data

+ Comment on the interpretation of strength assortativity for this dataset

+ Comment on the conclusions you can draw via the inference of the UBCM, DBCM and DECM models

A06.1 Hints

+ for undirected networks, make sure you symmetrize the adjacency matrix or use `G.to_undirected()`

+ Use library `NEMtropy` to fit ERGMs

+ Refer to the hands-on for a detailed introduction to the methods

+ Reciprocity for directed networks is the fraction of bidirectional links and can be obtained with `nx.reciprocity(G)`

+ For strength assortativity, use `nx.degree_pearson_correlation_coefficient(G, weight='weight')`

A06.1 Datasets provided

[1] K.S. Gleditsch, Expanded Trade and GDP Data. *Journal of Conflict Resolution*. 2002:46(5):712-724.

Data is in `graphml` format. Networks are directed and edges (i, j) have a **weight** attribute which represents the value of trade from i to j in million US\$

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