

Representing complex network structure through relational quasi-equivalence classes

The functional roles played by interactive agents lead to specific patterns in the link structure of their interaction network. Understanding complex multi-agent systems from the social, life, or biosciences requires understanding of the complex topology of the underlying network. To identify sets of role-equivalent agents we combine ideas from spin glass physics and social network analysis to develop a framework for automatically decomposing ("block-modeling") the functional classes of agents in a (multi-relational) network. The functional classes and their patterns of connectivity are represented in a resulting image graph, depicting a large network as a small one in a quasi isomorphic way. Our cost function finds the optimal image graph and simultaneously maps agents into functional classes. The method handles directed and undirected two- and one-mode data, weighted networks, finds an optimal number of roles, and is computationally efficient and non-parametric. Applied to the world trade network, countries are grouped into classes with similar commodity bundles of trade relations with others. The image graph shows preferred links where the trade volume exceeds the expectation value given countries' total import and export volume.

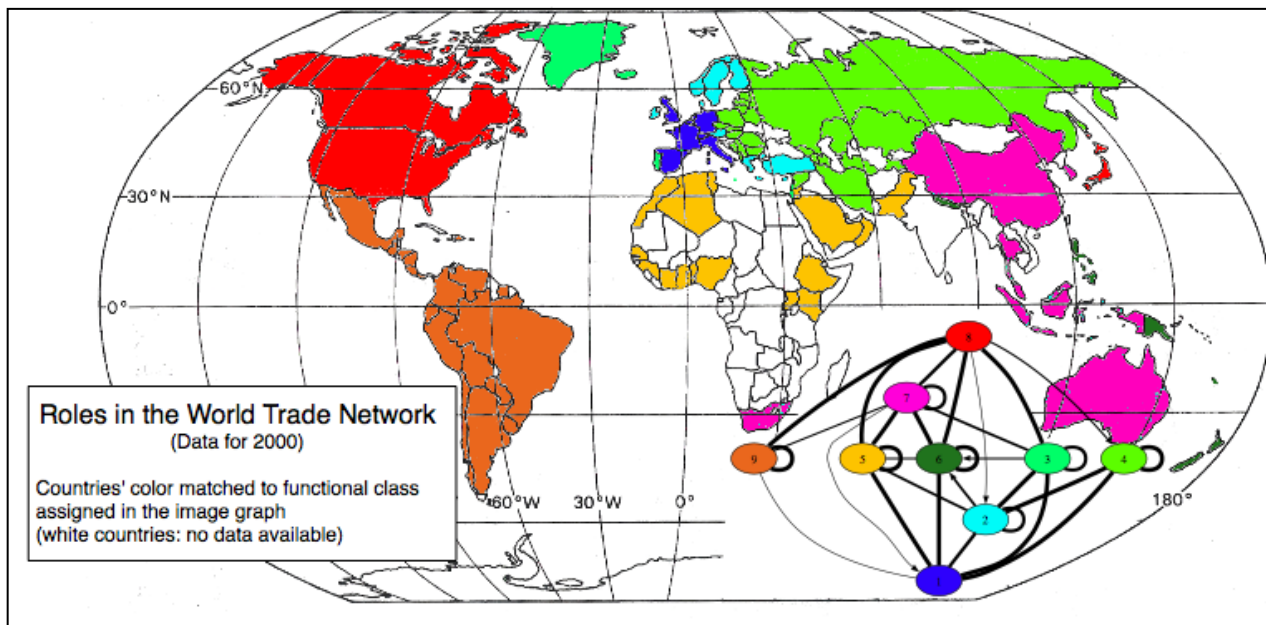


Figure 1: Representation of the world trade network as found by our block-modeling procedure. Countries are grouped into 9 functional classes with two opposing centers (North America/Japan and the European Union), parallel sub-centers in South East Asia and smaller European Countries, and two large peripheries in South America and Eastern Europe. A change in the cost function that regroups the image to include parallel symmetries (regular equivalences) in the graph has the potential to show the three symmetric layers of core, sub-center, and periphery in the image graph that reproduce the three-tiered structure of the world economy (D Smith and D White 1992 Structure and Dynamics of the Global Economy: Network Analysis of International Trade 1965-1980. *Social Forces* 70:857-894).