NETWORK STRUCTURE

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Network structure refers to a general system, network, or pattern of relationships that can be derived from the observable behavior of animate and inanimate actors or objects in a given population. Structure is usually understood as the arrangement of parts or elements of some complexity tied together by relations. The study of these relations is the subject of network theory. A network consists of nodes and links that form dyads, triads, groups, or a system of interconnected animate (actors) and inanimate objects, based on the specific types of relationships between them. In a dyad, ties come together, through the type of relation, to create a system of interdependence. Triads are fundamental network structures. There are 16 types of triads in a directed network in which balanced relationships or structural holes can be analyzed. This entry further defines network structure and then discusses the theoretical concepts behind it, basic types of networks in terms of their topology, and the measurement of network topology.

A network is dynamic by nature. Within network structure, nodes and relations are established, maintained, or broken (deleted), determining similarity between attitudes and behaviors. There is a shift from individual-level analysis to relational and systemic research.

Network structure and networks are an excellent way of presenting phenomena and objects from the perspective of the network of relations, interactions, and interdependence between them. Animate objects (e.g., human entities, organizations, animals), inanimate objects (e.g., things, artifacts), or contemporary epidemiological phenomena are mutually dependent on each other, creating an extensive, complex, and dynamic network structure. Many complex systems have a network structure. The most popular of them are the Internet, World Wide Web, and the citation network. Contemporary realities have driven researchers to focus on understanding the structure of the network of contacts during epidemics, which has a decisive impact on the dynamics of the spread of diseases. Determining this structure allows effective interventions to control and prevent epidemics. Standard research and social and behavioral methods pay attention to the attributes and characteristics of individual actors, which are studied independently of each other. Contemporary research in social or natural sciences, in which networks play a key role, focuses on the structure of the relations that exist between entities or objects.

Theoretical Concepts

In social sciences, network theory includes two popular concepts: the strength of weak ties, which can be considered to be within the framework of labor market theory, and structural holes, which are included in the sphere of competition theory. Within these two concepts, it is crucial to clarify the relationship between network structure and performance based on the position of the nodes in the network. According to Mark Granovetter, within an American job search context, the stronger the ties are between a couple of people in a given community, the greater the chances are of weaker ties with third parties (bridging ties) as a potential source of new information and knowledge. In turn, the term structural holes refers to a pattern of relationships in at least two unrelated social networks, where an actor is associated with many other networks that have no connection with each other. Such structural properties of the network give an actor the chance to receive nonredundant information, which favors innovation. These theoretical constructs aim to capture the network's structural features and study their impact on network participants, patterns of network creation, and change.

Complex Network Topology

The structure of the network as a whole is called network topology. There are many network topologies and among the most popular are small-world networks and scale-free networks, the properties and expected behavior of which differ.
In a small-world network, it has been found that a small number of relations between two random entities occur regularly in different systems where there are short paths, and its theoretical model is small in diameter.

Moreover, it has a relatively high clustering factor. Research into the characteristics of the small-world network structure has been conducted in the context of college classes and the implications of the spread of an epidemic at universities or hospital work organization.
Scale-free networks are the result of the dynamic emergence of networks and the preferential (not random) relation of subsequent nodes that are more likely to connect to those with a greater number of relations (hubs). Scale-free networks are immune to random events that may affect their structure, provided that the events are not aimed at central nodes. Examples of research on scale-free networks are modeling the belief system and the spread of biological and computer viruses.

Network Structure Measures

Network structure can be studied and measured with social and dynamic network analysis, which allows the study of network topology, network behavior, and evolution, as well as an understanding of why networks are structured the way they are. This analysis reveals the privileges of some nodes and the advantages of some types of networks over others. The basic measures at the whole network level are density and centralization.

Density measures the actual number of links between nodes in relation to all links that exist. This allows the assessment of the degree of networking of the studied system or population. Centralization refers to the overall integration or coherence of the network. It determines the relative dominance of a single node over others in the network and then the entire network is characterized by a centralized structure in which there are many links around one node. Conversely, a network structure takes a decentralized form. Both the dense and centralized network structures have inevitable positive and negative consequences. Network structures, and positions in the network, create both opportunities and limitations depending on the functional value of the relationships studied. The network's overall efficiency can be assessed through the prism of possible fragmentation and the redundancy of nodes or relations.

FURTHER READINGS

Carolan, B. V. (2013). *Social Network Analysis and Education: Theory, Methods & Applications* (First Edition). Thousand Oaks, California: SAGE Publications, Inc.

Newman, M. (2018). *Networks* (2nd Edition). Oxford University Press.

Ujwary-Gil, A. (2020). *Organizational Network Analysis: Auditing Intangible Resources*. New York, NY: Routledge.

Valente, T. W. (2010). *Social Networks and Health*. New York, NY: Oxford University Press.

Wasserman, S., & Faust, K. (1994). *Social Network Analysis: Methods and Applications*. Cambridge, UK: Cambridge University Press.