THE NETWORK APPROACH: CONCEPTS AND APPLICATIONS

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Networks are present in various dimensions of daily life, although they are often not perceived. Essential services upon which modern society depends are structured in networks, such as transportation, telephone, sewerage and electrical energy, water and food supply. Social actors, whether individuals or organizations, are part of social networks and through them circulate information, knowledge, collaboration, money, rumours and even illness. Networks of interactions are also very common in the natural world, whether on the intracellular level of living organisms or among species that live in a certain ecosystem (Barabási, 2003).

The graphic representation of any of these examples (railways, energy distribution, communications, food chain, scientific collaboration, social movements) results in a set of points that are connected directly or indirectly, conforming to a structure. Various disciplines are dedicated to the structural analysis of networks, because it is useful to explain the interaction between objects, molecules, genes, stars in a galaxy, atoms or people. The process consists, above all, in an analytical focus that is applicable in a wide variety of fields, that some call a "science" and others consider being a transdisciplinary field (Watts, 2003).

In sociology, the study of the interaction between individuals and or organizations is called social network analysis, based on the assertion that the standards of social interaction have consequences on the actors involved. An analytical focus on networks has been present in the social sciences since the eighteenth century and involves different schools of thought (Freeman, 2004). Among the precursors are the ideas of German philosopher-sociologist Georg Simmel who, intrigued by the phenomenon of urbanization at the end of the nineteenth century, developed a profound analysis of the forms of affiliation of individuals and the types of resulting interactions in the different typologies (Simmel, 1955).

More recently, a well recognized study by Milgran (1967) sought to test the hypothesis of what he called "the small world problem", or that is, any person can be contacted with the intermediation of a few people connected in their network of friends. To measure the distance between unknowns he conducted an experiment requesting that individuals living in the U.S. state of Nebraska have a letter reach an unknown individual located in Boston. The results showed that, to reach the destination, the letter passed through an average of six individuals, including the sender and receiver.

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This theory, denominated "six degrees of separation" is until today the object of mathematical studies to define models and understand the structure of social networks, and perhaps to deduce elements that allow extrapolating to studies of networks in other disciplines (Kleinberg, 2000).

The quantitative analysis of social networks came to be considered the most systematic form since the 1930's, supported in concepts developed by its predecessors. In the field of the mathematical sciences, the first theoretical formulations about the structure of networks were made by Euler in the eighteenth century, based on the development of a theory of graphs (figures with vertexes and arcs). In the language of social networks, the vertexes represent the points or people and the arcs the lines or connections. With the development of computer sciences and the expansion of analytical tools, interest grew among physicists and mathematicians about the statistical properties and modelling of networks, bringing new analytical tools to the different disciplines that use this approach (Newman et al, 2002; Girvan et al, 2002; Radichi et al, 2004).

In the realm of social networks, metric analyses allow identifying the roles of different actors according to the structural properties of the network. There are various types of measures, including:

- The Degree of centrality: this indicates the number of direct connections that an individual has and which, in a certain way, indicates his or her degree of "popularity" in the network;
- The Centrality of intermediation: indicates the frequency of the flow of connections that pass through a certain node or the degree of influence that an individual or organization has on the dissemination of information by the entire network;
- Centrality of proximity: measures the distance in relation to the set of actors that compose the network and indicates, for example, how much time it will take for the information to reach the entire network.

Some properties of networks are described with mathematical models that seek to quantify, in addition to the parameters mentioned, the existing groupings (or clusters) or that is, sub-groups with a high density of connections that are formed within the network. Metric studies of the structure also demonstrate that networks are spaces for "searching" or that is, they allow access to resources that are not immediately available through direct contact (Watts et al, 2002).

A classical study about structural properties analyzed a movie actors network, an energy transmission network in a certain region of the United States and the neural network of a nematode (*Caenorhabditis elegans*) (Watts & Strogatz, 1998). The researchers observed that, in the real world, networks have defined properties, whether they are social networks (of people or

organizations), networks of proteins in a living cell, or networks of information (Internet addresses, etc). In addition, they concluded that the structure of a network – number of members, number and quality of the connections between the members, types of groupings, etc. - significantly influences the network dynamic. The structure determines how the interactions take place and to what degree each member catalyzes or neutralizes processes, such as, the dissemination of information.

The metric analyses are in a developmental stage and are the object of controversies among scholars. The debate focus around the questions of the robustness of the results generated, the parameters that best suit the structural analysis and the degree of applicability of the analysis of networks involving human relations (Wellman, 1988; Newman, 2005; Zemlij et al, 2005). The complexity of these studies include the search for classification systems on network types to identify common elements that allow generalizing models for different environments (Milo et al, 2004).

Over the decades, a variety of disciplines have adopted this theme and analyzed networks from their own perspectives, often in a parallel manner. Even within a given discipline, it is possible to find different approaches and focuses to the studies, as is the case of organizational networks (Borgatti et al, 2003). In addition to the natural or social sciences, the analysis of networks have won considerable space in disciplines such as genomes and neurosciences, receiving from some authors the status of a "near discipline" (network biology in Barabasi et al, 2004). In the field of health, the modelling of networks is used to understand the spread of disease, supported by concepts from the social networks and specific mathematical models developed since the 1950's.

In the reverse direction, methodologies and models used in epidemiological studies inspire research about the spread of innovations, which seek to explain the factors that influence the process of distribution and adoption of new practices and technologies (Valente, 2005). Research in a rural community of Finland about factors that lead to conversion of properties for the system of organic production identified spatial proximity as one of the probable causes for the adoption of this system of production by the farmers studied (Nyblom et al, 2003).

The analysis of organizational networks (*organizational network analysis* – ONA) is another current application (Cross et al, 2001; Gobbi et al, 2005). Studies reveal that the structure of groups influences the circulation of information, which, in turn has implications about the performance of the organization in question (Cummings et al, 2003). This approach considers that the organizational structures that impede the lateral communication between groups have strong affect on final performance, particularly in complex, non-routine works. Structures with greater density of relations allow that the expertise found in a certain group be shared more efficiently and evenly among the various integrants.

Borgatti (2005) highlights that research and development networks with low centrality of proximity, or that is, with little distance between the members, are better able to develop products and results, given that the routes for the circulation of information are shorter. The hypothesis is that the lateral communication allows people to get to know each other, and as a result, the capacities and resources of the group are established as a common good accessible to any member.

The possibility for direct connections aggregates greater potential to the network, but on its own is not enough. Confidence is an essential ingredient for cooperation and an exchange of interactions between individuals and this demands time. In situations in which, for different reasons, the adhesion to a certain network or relations occurs before the interpersonal relations and trust are established, Cook (2005) suggests the adoption of formal norms and agreements as a safeguard for the risks that the adhesion to a "non-likes" network involves.

Nevertheless, the presence of differences and the existence of diversity are not necessarily an obstacle. Lin (2005) proposes diversity as a parameter to be considered in the analysis of social networks. Unlike the networks that congregate only "likes", the author suggests that, the greater the diversity of lifestyles and of abilities of the members, the greater the possibilities for sharing and adding new things, pondering that there are also risks such as "*fragile common interests and consequently, weak interaction, and a base of solidarity and cohesion*".

The emergence of the non-governmental sector and the greater visibility of the actions of organized civil society have stimulated studies that focus on solidarity networks in which the strengthening of inter-relations concentrates the existing resources in the group around a common cause. Reciprocity or expectation of reciprocity is one of the stimulants to actions of this nature, generating a positive cascade effect and strengthening the existing resources (Plickert et al, 2005).

Currently recognized as a standard form of action of organized civil society, certain principles are customarily attributed to actions in a network such as: interdependence, insubordination, equality, deconcentration of power, multi-leadership, and connectivity. In the organizational field, some conditions are defined so that the network can explore its potential to the maximum. Ayres (2002) highlighted the following factors: a unifying proposal, independent participants, voluntary interconnections, multiple leaders and extrapolating borders (spatial and hierarchical).

The development of new technologies and the mediation that they exercise in social relations led to the term "network society", broadly discussed in the trilogy by Castells (1996). He

argues that the demand for greater velocity imposed by globalization, requires hierarchical and bureaucratic organizations to make their structures more flexible, while this option for a network is not necessarily motivated by noble goals. Therefore, according to Castells, network is not synonymous with something pure and perfect:

> "Networks do not have their own feelings. They kill or kiss. What makes a network depends on its program, resulting from a social and cultural process." (Castells, 2001)

Organization in network also does not mean that all the members are equal and play the same role. In graphic representation, these differences are clearly observed, and in the real world, the different roles of each actor involved are also observed. Studying networks of social movements as routes for the dissemination of knowledge, Marteleto (2001) identified the following categories: mentor (formulates the ideas), articulator (mediates and facilitates contacts with different sectors), translator (expresses ideas in a conversational manner, mediates knowledge from the exterior to the interior of the network); facilitator (makes things happen), cosmopolitan (influences certain groups in the network). Moreover, the interaction between these different roles does not take place without conflict, which is useful for extravagating tensions, according to Simmel:

"[conflict] is a form of achieving unity…it is parallel to the more violent symptoms of a disease, which represents the effort of the organism to free itself from the disturbances and damages that it causes…A harmonious and centripetal group, a pure unification, is not only empirically unreal, it cannot display a real living process". (Simmel, 1903)

Conflict is one of the elements that provide dynamics to social networks, and by any means, these cannot be considered a static body represented in diagrams. A better understanding and representation of the dynamic character of networks still depends on theoretical and analytical development (Willer et al, 2000; Strogatz, 2001). Finally, the structure itself is not everything. There are subjective factors such as the individual motivation of the actors, which strongly influence the results of the dynamic in a network, as demonstrated in the global study of the degrees of separation on the Internet (Dodds et al, 2003).

In any case, whether from the perspective of the social sciences – sociology, anthropology, psychology – or in the natural and physical sciences, the theory of networks provides useful elements to consider the necessary conditions for an effective network action. Even if they do not consider the subjective dimension of human relations, the graphs and mathematical models used by the structuralism school have valuable lessons when considered in the light of the rules and

theorems that guide them. Therefore, for the purpose of thinking the ABN functioning system, the following assumptions on networks could be taken in to account:

(i) Social networks are live, dynamic and systemic organisms, presenting "ups and downs" momentums.

(ii) Process generation is an expected resulted of network action though not always possible to measure or to control.

(iii) Diversity of capacities and needs as well as commonalities on vision and values motivate network action.

(iv) Each node – an organization or a person - influences the network dynamics, according to its own personality/ capacities/ needs/ interests/ commitment/ initiatives. Therefore, changes in network composition and/or nodes roles lead to changes in the network dynamic.

(v) The network is not the exact arithmetic sum of its members. Interactions and flows among "nodes" may generate process/results not achievable individually.

(vi) Conflict is not a disease. It is part of social interaction and provides opportunities for collective learning and development.

(vii) There is no recipe or an ideal model for network structure and functioning.

(viii) Each network has its own rhythm of growing and expansion.

(ix) Network quality cannot be measured according to its longevity or size. Its capacity for catalysing and generating process are much more useful parameters.

(x) Good communication flow among nodes – directly or indirectly - is the essence of network action and what makes it searchable and catalytic.

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