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Networks and SST coupled to map science evolution.

A structural model to map social systems.

GabrielVélez-Cuartas

Affiliation University of Antioquia, Sociology Department, Social Science and Humanities Faculty,
Address Calle 70 No. 52 - 21 | Apartado Aéreo 1226, Medellín, Colombia,
E-mail gabrielvelezcuartas@yahoo.com.mx,
Phone(0057) 4 3174397234

Abstract: *Meaning as an emergent phenomenon is composed by two constructive processes according to Luhmann's SST. The first refers to personal experience: memories and choices experienced by consciousness. The second is related to cumulative social experience as a horizon of possibilities. These possibilities make communication possible.. This work presents an exploratory model that depicts meaning as a process of cumulative experience enacted by signs or information organized in networks of communications. Communications in this sense are enunciations that imply thematic issues interconnected through words and other kinds of situational information that can be perceived. If we classify the types of information exposed in a social communicational event it is possible to find repetitions and variations of information from past events. Communication events related through occurrence and variation can be depicted in networks. If social systems are codified as Luhmann suggests, we could find structures of information that imply genealogies that express the continuation of autopoietic processes in systems. This paper aims to demonstrate how the scientific social system, understood as a system of communication events where thematic issues emerge, could be mapped through juxtaposed networks of different kinds of codified information.*

The following case exemplifies recent studies of the developments in the social network analysis field Meaning networks are applied as tools for the indexation of thematic issues using network analysis and social systems theory.

Keywords: Meaning networks, social systems theory, communication theory, scientific communication

This paper argues that meaning dynamics could be represented through network analysis. We aim to demonstrate that analytical principles that have been developed in graph theory, set theory and/or calculus and algebraic matrices can be usefully applied to the representation of meaning. For our purpose, we will start by examining two basic principles: aggregation and distinction. The first principle, aggregation, comes from set theory. A set is an aggregate of elements arranged according to one or more rules that define boundaries and possible operations between these elements. The second principle, distinction, has been recently developed by George Spencer-Brown (1977). This mathematician proposes a set of axioms and theorems to define an operation that is previous to aggregation. In the introduction to "Laws of Form", Spencer-Brown argues that the introduction of the concept of distinction would resolve logical paradoxes in the definition of a set (already discovered by Bertrand Russell at The Principles of Mathematics, 1938)[1].

The cognitive operation of distinction is different from the cognitive operation that defines a well ordered set. A well ordered set supposes that reality shows itself to a rational and perfect consciousness. This kind of consciousness could define perfectly all those necessary conditions of aggregation to identify structures, organization forms and possible relationships (Cantor, 1915). Opposed to this point of view, a distinction emerges from a constructivist dynamic between observant and observees, where observees elements change meanwhile the observant is trying to simplify its dynamics to its own changes to couple, to assimilate or to destroy such an element (exactly as Francisco Varela pointed out, 1998).

If we combine the principles of aggregation (from Cantor) and distinction (from Spencer Brown) we will have the possibility of modifying certain ways to borderline a kind of evolutive dynamic in the definition of sets. This means that representations of sets could consider elements present into two different sets at the same time, depending on distinctions associated to that element. With the introduction of distinction, elements could be paradoxical if we use theories of evolution and closed systems.

[1] If we try to represent dynamics from self organized systems, paradox is always present in their operations. For instance, if we take a social system (understood as a system of communications), an event of communication is a selection of information of past events pointing their equivalence to be understood but always been different. This is why a representation of communication as a set of events always will have elements that belong to that set and at the same time different from it.

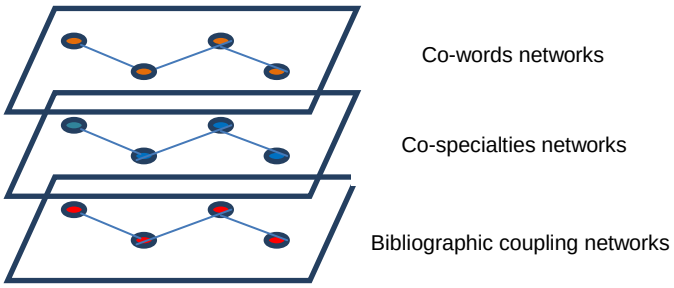
Once aggregation and distinction as principles had been defined we have to introduce the concept of relationship. A network is a set of points linked by some kind of relationship. If we understood that identity of elements is determined from a structural point of view by their relations (or from a systemic point of view by their operations), we would not locate identity paradox in the elements but in their relationships. This means that paradox may be solved if we find a representation form that accepts elements from a set that can be related with different elements that permit define their identities from different point of views.

Cognitive principle introduced by distinction open a dialogue between observant and observee elements. First, observant aggregates elements from a first distinction. Then, by discovering relationships between elements, for example, co-presence of elements in different events that can point a link between them (in form of a network). These relationships make able a further distinction that aggregate elements according to common characteristics. These elements belong to different aggregates although they remain the same in identity. If we consider these elements as parts of events we will be able to infer some kind of self dynamic that is organized by an observant that tries to formalize external behaviors according to its cognitive abilities.

There are three remarkable things that could be outlined from these assertions. First one is that we are assuming that interconnected events by co-presence in the realm of social things could be already interpreted as social dynamics. From Luhmann's (1998) social systems theory, we could find that continuity of communication events could be expressed empirically as forms of selection/variation/stabilization due to meaning dynamics: selection from previous events, variation as new forms of the same contextualized, and stabilization as duration. Stabilization describes time, and selection and variation cluster events. Second, as events or as elements of a set we are considering entities that are aggregated because they belong to a dynamic system; in Loet Leydesdorff words: in an empirical study, system always remains as a hypothesis (Leydesdorff, 2001b). With this consideration, we have to relate selection processes as structural ones, exactly as Luhmann (1998) proposes in chapter 8 of Social Systems (Structure and Time). Then a system operates in a structural form taking past events as references. In this way, the emerging of new events consider past information that has been communicated in a new form. Third, it's possible to consider one event as a multi-layered entity that contains different forms of information. This means that a communication event is composed of multiple marks or units of information which together give meaning to that event.

For instance, if we have a set of elements defined as key words from a file of scientific papers related with a scientific issue or specialty, we could find that many of these words repeat themselves in different articles. These key words presented as a relationship of co-occurrence give some primitive (or imprecise) meaning to a group of events. But aggregating another kind of information presented in different events and linking it by co-occurrece as references and specialties, meaning could be specified. Schematically, this can be represented as follows in figure 1.

Figure 1. Communication events as multi-layered networks.



Argumentation in science, according to Luhmann (*Die Wissenchaft der Gesellschaft,* Translated to Spanish as "La Ciencia de la Sociedad", 1996) operates through three main components: prestige, clarification and specialization. These three components are composed by scientific concepts as transversal operators. If we try to represent these as information contained in papers (named as communications) we will tell that the task of argumentation is to build concepts. Scientometrics has specified denominations to obtain operations of argumentation: prestige associated with volume of cited references (see De Solla Price, 1973 [1963]), specialties as journals subscription to different fields (see for instance L. Leydesdorff analysis, 2001a) and clarification[2] could be related to evolution of aggregated words in subsets of thematic issues combined with their genealogies also called invisible colleges (see De Solla Price, 1973 [1963]). Each one of these kinds of

[2] Although there is not a logic method inside Scientometrics to represent debates, there is an exception in the model of discourse synthesis presented, for example in a compilation made by Raymond McInnis (2001).

analyses could be represented in networks. Juxtaposition of these networks could specify meaning in a set of texts.

In summary, network analysis could be used as a tool of representation transforming some principles of set theory, changing some procedures in matrix disposition of elements according to Spencer-Brown's distinction logic. This derives in juxtaposed networks linking communication events thinking in a structural disposition of systems, whether we understand structure as events genealogies of kinds of information.

The case of *Social Networks Analysis* field will be presented through 487 articles taken from the most representative journals in English and Spanish, like Social Networks (from Elsevier) and Redes: Hispanic Review for Social Network Analysis (from Autonomous University of Barcelona). Juxtaposed networks were depicted. Their analysis let us discover beyond descriptive analysis features of *limitationalität*[3]

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About the Author

Gabriel Vélez-Cuartas

PhD in Social and Political Sciences (tutored by Dr. Javier Torres Nafarrate, main translator to Spanish of NiklasLuhmann works). Master in Communication Studies (Monograph made on Interorganizational Networks). Assistant professor of Sociology Department at University of Antioquia (Colombia).Director of Social Networks and Actors Research Group (this group has been recognized by Administrative Department of Science, Technology and Innovation, Colciencias –equivalent to a National Governmental Council for Scientific Research). Member of Scientific Committee of Redes: Hispanic Review for Social Network Analysis (main diffusion media for Social Network Analysis in this language). Memberships: International Sociological Association: RC51, RC23 and RC33; International Network of Social Network Analysis (INSNA). Production: 24 publications, 32 conference papers and 10 research projects besides teaching experience on research and consulting. Issues developed are associated to the improvement of tools for social network analysis (in the fields of interorganizational networks, policy networks and science mapping), social systems theory and communication theory (communicology). Two different models have been created: Structural Performance and Meaning Networks. First one is based on Giddens Structuration Theory and network analysis is applied to different levels and dimensions to interorganizational analysis. Meaning Networks is the model presented at this session using Social Systems theory applied to network analysis of scientific production.

[3] A concept proposed by Luhmann in Die Wirtschaft der Gesellschaftthat describes boundaries of theories from a second order analysis.