

ANALYSIS OF E-COMMUNICATION IN ORGANIZATIONS

A research team is developing tools based on the theory of complex systems to analyze the structure and behavior of firms in a non-intrusive, objective, and quantitative way.

Principal Investigator: Luis A. N. Amaral

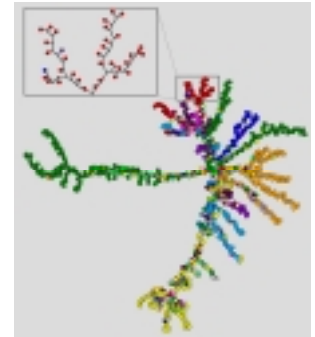
Collaborator: Alicia Löffler (Kellogg School of Management)

Objective: Understanding of the formation and structure of complex informal networks, which arise between individuals for personal, political, and cultural reasons is critical for successful management of business organizations. The traditional way of investigating such informal networks involves conducting surveys using questionnaires and has significant limitations because employees' answers are often biased by "political" motives and the worry about offending colleagues. Another pronounced drawback of the questionnaire-based analysis is that time and effort costs make it prohibitively expensive to map the entire network even for medium-sized firms. The rapid development of electronic communications provides a powerful alternative to the traditional analysis of informal networks and, more generally, to the traditional tools used to determine the structure and behavior of firms. Indeed, the exchange of e-mail messages between individuals in an organization can reveal how people interact and allow mapping of the informal network in a non-intrusive, objective, and quantitative way.

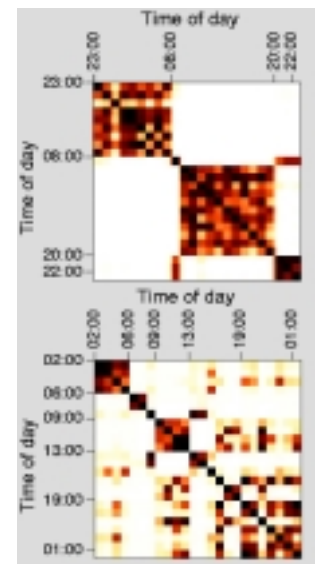
Approach: The researchers are using tools borrowed from statistical physics and the mathematical theory of complex systems to analyze large data sets obtained from automated tracking of digital communications, which amount to hundred of thousands of electronic communications per week even in medium-sized organizations (*e.g.*, 1,000 employees).

Results: The research team led by Dr. Amaral has developed theoretical tools to analyze the time series that result from the interactions between many "agents" in complex social, economic, biological, and physical systems, as well as to describe the complex networks, which arise from such interactions. In particular, it has been shown how communication patterns in organizations can be used as an objective indicator of their status and evolution. The researchers have applied their technique to a real organization with 1,700 employees and correctly identified work teams, collaborating departments, and groups of departments with no *a priori* information about the structure of the company. The Amaral team has also shown that a statistical analysis of the traffic of information in the computer network of an organization reveals patterns, which can help to assess how the organization actually works. For example, they have demonstrated that it is very easy to distinguish between a university and a business firm using such analysis.

Selected Publications: Amaral LAN, Scala A, Barthelemy M, Stanley HE, *PNAS USA* **2000**, 97:11149; Arenas A, Diaz-Guilera, Guimera R, *Phys. Rev. Lett.* **2001**, 86:3196; Guimera R, Arenas A, Diaz-Guilera A, Giralt F, *Phys. Rev. E* **2002**, 66:026704; Guimera R, Arenas A, Diaz-Guilera A, Vega-Redondo F, Cabrales A, *Phys. Rev. Lett.* **2002**, 89:248701; Guimera R, Danon L, Diaz-Guilera A, Giralt F, Arenas A, *submitted* **2003**; Guimera R, Guardiola X, Arenas A, Diaz-Guilera A, Amaral LAN, *submitted* **2003**; Fukuda K, Amaral LAN, Stanley HE, *submitted* **2003**.



Community structure of a real business organization with 1,700 employees. Each branch represents a community, with sub-branches representing teams.



Statistical analysis of the traffic of information in a business firm (top) and in a university (bottom).