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The Effects of Topology on the dynamics of Naming Games

Andrea Baronchelli‡, Luca Dall'Asta†,
Alain Barrat† and Vittorio Loreto‡§

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Abstract

The study of language as the result of a complex adaptive system allows to understand how a population of agents can develop a coherent set of linguistic conventions on the basis of simple interactions and negotiating processes. Among the language games used to study the evolution of language, Naming Games (Steels, 1996) are conceived as simple models reproducing the dynamics by which a word or a minimal set of words are selected as a commonly shared vocabulary to identify one or more objects. We consider a minimal model of naming game in which all interactions among pairs of individuals, one selected as speaker and the other as hearer, are focused to communicate the name of a single object. At each step of dynamics two agents discuss on the name of the objects, updating their inventory of words on the basis of the result of the game. A two-agents game has a success if the hearer understands the word pronounced by the speaker, i.e. if they both possess it in their words inventories. The type of dynamics favors the spreading of a word having high rate of success, with a final state in which all individuals share a single common word to identify the object. We study the effects of topological constraints on the dynamics embedding the system in graphs, where the agents can interact only with their neighbors. The emergence of a common linguistic convention for the object's name seems to be solid with respect to different topological structures: regular (1D and 2D lattices), homogeneous random graphs and heterogeneous scale-free graphs. However, the temporal scale of the dynamical process as well as the evolution of spatial structures (groups of agents sharing a words) show a variety of interesting different behaviors, that are analyzed using both analytical and numerical techniques. In particular, the dynamics on low dimensional lattices is characterized by diffusive phenomena that are explained using a simple master equation's approach.

*† Laboratoire de Physique Théorique (UMR du CNRS 8627), Bâtiment 210 Université de Paris-Sud 91405 ORSAY Cedex - France
‡Dipartimento di Fisica, Universitá "La Sapienza", P.le A. Moro 2, Roma, Italy