COEXISTING LINGUISTIC CONVENTIONS IN GENERALIZED LANGUAGE GAMES

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The Naming Game is a well known model in which a population of individuals agrees on the use of a simple convention (e.g. the name to give to an object) without resorting to any central coordination, but on the contrary exploiting only local interactions (Steels, 1996; Baronchelli, Felici, Caglioti, Loreto, & Steels, 2006). It is the simplest model in which the idea that language can be seen as a complex adaptive system (Steels, 2000) has been applied and challenged and it has therefore become prototypical. Indeed, its simplicity has allowed for an extensive application of complex systems concepts and techniques to various aspects of its dynamics, ranging from the self-organizing global behaviors to the role of topology, that is unprecedented in the study of the emergence and evolution of language (Baronchelli et al., 2006; Baronchelli, Dall'Asta, Barrat, & Loreto, 2006). However, while the Naming Game provides fundamental insights into the mechanisms leading to consensus formation, it is not able to describe more complex scenarios in which two or more conventions coexist permanently in a population.

Here we propose a generalized Naming Game model in which a simple parameter describes the attitude of the agents towards local agreement (Baronchelli, Dall'Asta L., Barrat, & Loreto, 2007). The main result is a non-equilibrium phase transition taking place as the parameter is diminished below a certain critical value. Thus, the asymptotic state can be consensus (all agents agree on a unique convention), polarization (a finite number of conventions survive), or fragmentation (the final number of conventions scales as the system size). More precisely, it turns out that, tuning the control parameter, the system can reach final states with any desired number of surviving conventions. Remarkably, the same dynamics is observed both when the population is unstructured (homogeneous mixing) and when it is embedded on homogeneous or heterogeneous complex networks, the latter being the most natural topologies to study the emerging properties of social systems (Baronchelli et al., 2006).

We investigate the general phenomenology of the model and the phase transition in detail, both analytically and with numerical simulations. We elucidate the mean-field dynamics, on the fully connected graph as well as on complex networks, using a simple continuous approach. This allows us to recover the exact critical value of the control parameter at which the transition takes place in the different cases.

In summary, our generalized scheme for the Naming Game allows us to investigate, in a very simple framework, previously disregarded phenomena, like for instance the possible coexistence of different linguistic conventions in the same population of individuals. The complex systems approach, moreover, provides us a deep understanding of the mechanisms determining the realization of the different asymptotic states, namely consensus, polarization or fragmentation.

References

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