



DYNAMICS AND COLLECTIVE PHENOMENA OF SOCIAL SYSTEMS

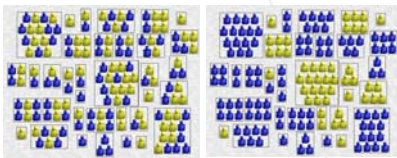


* Social systems are prominent examples of complex systems. Concepts, tools and models aiming at identifying generic mechanisms underlying collective phenomena in these systems are developed with the use of Game Theory, Statistical Physics, Agent Based Models and Complex Networks Theory. Cooperation, cultural conflicts and problems of social consensus are examples of phenomena being addressed.



OPINION FORMATION

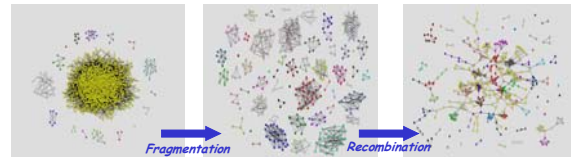
A general question in the problem of social consensus is determining when the dynamics of a set of interacting agents that can choose among several options (political vote, opinion, cultural features,...) leads to a consensus in one of these opinions, or when a state with several coexisting options prevails. The answer depends on the mechanism of interaction and the network of interactions. Mechanism considered in opinion formation include imitation, bounded confidence, homophily, social pressure and individual thresholds, etc.



The figure illustrates an implementation of social pressure by a majority rule in meeting cells. Agents are redistributed in meeting cells in subsequent time steps.

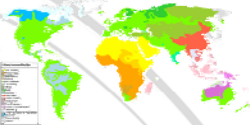
COEVOLUTION AND GROUP FORMATION

In the coevolution dynamics of agents and network, the structure of the network is no longer given but a variable: The goal is to explore how a social structure might evolve in tandem with the collective action it makes possible. In this framework, dynamical processes of group formation generically appear associated with network fragmentation transitions.



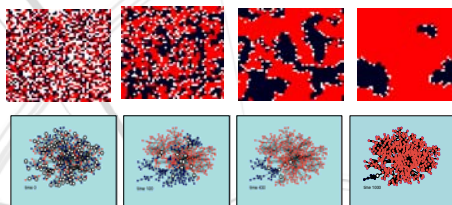
Varying the ratio of the time scales of evolution of the state of the agents and of the network, fragmentation and recombination transitions are observed.

DYNAMICS OF LANGUAGE COMPETITION



Within the general context of the dynamics of social consensus, agent based models for the dynamics of language competition are investigated. The role of bilingualism and social structure, modelled by complex networks of interacting agents, is addressed.

The snapshots show the evolution of two equivalent languages in a regular lattice and in a network with community structure. Bilingual agents (white dots) emerge at the boundaries and at bridges between language domains.



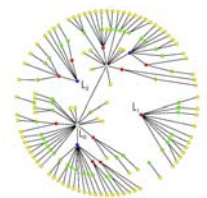
COOPERATION AND CONFLICT



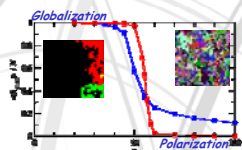
The emergence of cooperation in a group of agents has been traditionally discussed using the Prisoner's Dilemma. Cooperation may be sustained by reciprocity. Mechanisms of Conflict Dynamics can also be studied in paradoxical games such as Parrondo or Truel Games.



Cooperation is sustained in a Prisoner's Dilemma in an adaptive network as a result of heterogeneous neighbourhoods which arise in the dynamical evolution. This evolution leads to role differentiation among the agents with spontaneous emergence of leaders, conformists and exploiters. The figure shows the imitation network of cooperators with the absolute leader L_1 having the largest pay-off and the largest number of links.

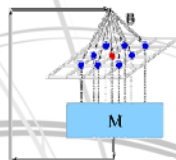


CULTURAL GLOBALIZATION / POLARIZATION



Competition between different cultural traits in the social interaction of agents with several cultural features leads to a nonequilibrium transition between a state of cultural globalization and one of persistence of cultural diversity ("polarization").

Mass media effects in cultural dynamics can be modelled as a plurality information feedback that competes with local agent-agent interaction. It turns out that mass media is only efficient in producing cultural homogeneity in conditions of weak broadcast of a message: *The power of being subtle.*



HETEROGENEITY IN COLLECTIVE ACTION



Herding behaviour is well known in social systems, for example among stockbrokers. The homogenous or identical behaviour of all agents is modelled by multiplicative processes leading to cascade phenomena.

Individuals in a society are however non-identical. Diversity, or heterogeneity, in the ensemble of interacting agents, i.e., the fact that not all agents are identical, is a mechanism for the appearance of coherent collective behaviour. This mechanism is not yet well understood, but it increases the capability to adapt to changing external signals: For instance, fashion adoption is optimal for an appropriate value of diversity.

