Spreading of cultural traits in spatially embedded networks

Vivian Dornelas[1], Els Heinsalu[1], and Marco Patriarca[1]
[1]National Institute of Chemical Physics and Biophysics, Akadeemia tee 23, 12618 Tallinn.

In a language community people use similar norms and terms for communication. However, inside a larger community, differences associated with sub-communities that interact with each other can appear. The interactions can be influenced by various factors, such as physical geography and economical connections.

Inspired by the example of the adoption of specific phonetic pronunciations in the Friuli region in North-Eastern Italy, we study an agent-based model of propagation of linguistic traits across a small number of sub-communities that are spatially close but still separated. Each sub-community is represented by a small-world network (Watts-Strogatz networks), where nodes represent individuals and edges represent connections between them. The small-world networks, representing the sub-communities, are connected to each other through some additional links, representing the interactions between the different regions, as depicted in Fig. 1. The diffusion of linguistic features is modeled by employing a generalization of the Axelrod model characterized by a minimum level of similarity between individuals, which ensures a finite probability that two connected agents communicate.

We consider as initial conditions that individuals within each small-world network have the same linguistic traits and innovations appear in a node. We studied various system configurations obtained by varying both the level of randomness of small-world networks and the number of connections between them, as well as the number of individuals.

Our analysis of the language features and the cultural clusters emerging within the network reveals several interesting aspects. First, sparse populations tend to be more heterogeneous, whereas populations that are more connected or dense are more likely to reach a consensus. In addition, the degree of connection between different sub-regions (networks) plays an important role in promoting diversity, with less connected regions exhibiting greater diversity in the global population. Furthermore, temporal oscillations in features variables appear within a regional population under certain conditions.

Overall, the findings of the present work highlight how the complex interplay between network structure and cultural dynamics can affect the spread of cultural traits in spatially embedded networks.

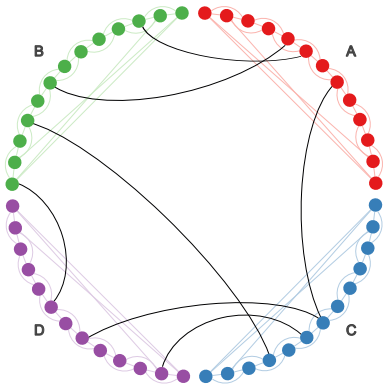

Fig. 1. **Network representing a community composed of four regions.** Each color corresponds to a different sub-community represented by a Watts-Strogatz network. Furthermore, black lines represent the interactions between the different sub-communities.