Agent Based Models to Simulate Social Support Networks

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(discussion abstract)

Purpose of the research

Healthcare is a complex phenomenon in which many individuals, groups, organizations interact by exchanging resources and information in a dynamic environment. Such settings can be modelled as dynamic networks made by a mix of human subjects that can exchange information through digital channels. The possibility to simulate the behaviour of such complex settings can provide powerful means for exploring "what-might-be" scenarios in which sustainability is addressed from an economic, social, and environmental perspective (Burton & Obel, 2011; Spagnoletti, Za, & Winter, 2013).

In order to address this challenge, we designed a methodological framework for guiding the emergence of aging support networks based on agents' simulation and on an ecological model of aging. In the last years the web 2.0 and digital tools are covered a relevant role in reinforcing the support network centred on the older, also improving the performance for achieving some specific goals based on information exchanges (Godfrey & Johnson, 2009). Since there are some distinctive traits between traditional and digitally enabled aging support network, the proposed architecture can be adopted to compare two scenarios of aging support networks: traditional vs. digitally enabled networks, viewing them as extremity of a continuum. In particular we make some hypothesis on the definition of goals, plans, actions and resources in both scenarios. Our aim is to show, from a theoretical perspective, how the properties of digital innovations together with their diffusion dynamics in small networks, can bypass the limits of traditional healthcare models. Furthermore these characteristics can provide some insights for guiding the design of new governance models and tools in the e-Health domain.

Theories used and contribution to the literature

Our main assumption in this study is that Agent-Based Models and Multi-Agent Simulations (MAS) have the potential to gain insights on the mechanisms that lead to sustainable healthcare. In fact the dynamics of health emerge from the behaviours and the interactions of heterogeneous individuals and hence interaction is the basic mechanisms that mediates social production of health (El-Sayed, Scarborough, Seemann & Galea, 2012). Therefore a model for studying agents' interactions must specify the characteristics of the agent, the connections among them and the mechanisms of their interaction (Macal & North, 2010). These features, together with the possibility of studying agents' achievements in terms of resources and information, their decision making processes and strategic actions (based on models of other agents and of environment), make MAS a suitable tool for supporting private and public decision makers in their activities of strategy and policy definition.

A recent study of e-Health good practices implemented in Europe in the last decade, identifies three main categories of e-Health projects (D'Urso, De Giovanni & Spagnoletti, 2013). The first category is focused on the support of administrative processes within a single healthcare organization (i.e., hospital, local health authority, etc.) and on possible interconnections with IT systems supporting clinical processes. The second category focuses on the support of clinical processes encompassing the physical boundaries of a single healthcare organization (i.e., hospital, laboratory, etc.) through remote data transmission. The third category is focused on providing support to integrated care processes with a patient-centred approach. Advances in the latter category have been identified in the diffusion of novel community centred platforms such as wikis that involve users in the production of contents (ibid). At each of these perspectives a core rule is played by the concept of network: more precisely, either in considering exchange within an organization, between organizations and in an environment constituted by several subjects related to a single patient, it is crucial to understand structural and dynamic aspects of the links that let all the subjects together be a system.

Research method

Although the behaviour of online (virtual) networks has been widely investigated in terms of community members' motivation and institutional aspects, the emergent properties/phenomena in social networks when social support is exchanged among members is less understood. The proposed framework is grounded on a cognitive model of dependence networks (Castelfranchi, Falcone & Marzo, 2006; Marzo & Castelfranchi, 2013) and provides a means for modelling the dynamics of aging support networks. These networks are seen as small groups of interacting agents whose behaviour is determined by their internal state and behavioural rules. We consider as agents all the subjects playing a role within an aging support network. The final goal of these networks are to support the elderly in her daily life and hence to improve her quality of life. Most of the nodes of these networks can represent relatives (husband/wife, sons, nephews, etc.), ex-workmates, neighbours, caregivers, and friends of the aged person.

In our framework, goals are the purpose of agents and to achieve them they have to perform needed plans of actions based on interactions guided by the believed dependence networks (Marzo, Za, & Spagnoletti, 2013). Following the point of view of the Complex Adaptive Systems (CAS), in which complex systems are open systems that interact with the environment and with other complex systems, the future is not predetermined but it is made by interactions. Systems themselves are the result of evolutionary processes during which successive levels of structure emerge (Allen & Varga, 2006). According to this perspective, plans can be more or less predictable on the basis of how the agents interact, and it is also related to how it is more or less easy for the agents to interact. Each plan is constituted by several actions, and each action can be performed thanks to specific capabilities and/or skills owned by agent, and it can involve a particular resource. Other agents can learn skills and capabilities through interactions, and then other agent can autonomously perform related action, if and only if either the both agents own the resource involved or the action does not need that resource. In the case in which skills and capabilities are learned, it is possible to observe their diffusion in the same network and among the networks (all those ones agent belongs to). We hypothesize that the diffusion of skills and capabilities can

follow the path described in agent-based modelling of social epidemiology (El-Sayed, Scarborough, Seemann, & Galea, 2012): the diffusion happens like "epidemic contagion" (viral diffusion). Agents may also be endowed with different amounts of resources or accumulate different levels of resources as a result of agent interactions. Digital resources rather than physical ones do not wear out and people can duplicate them practically without cost: physical resources are consumable and limited, whereas digital ones are replicable and diffused. Furthermore, considering digital resources as digital technology, their characteristics make their use easily affordable by almost anyone (Yoo, Henfridsson & Lyytinen, 2010).

Main results

We can hypothesize what happens for plans and goals in an aging support network if it is digitally enabled or not. Indeed, designing a simulation based on our architecture, the physical peculiarities of a resource and its temporal and spatial constrains become less relevant for digital resources. Moreover, thanks to the characteristics of digital resources, the skills and capabilities needed to use them can be easily transmitted from one agent to another. These characteristics of digital resources and actions can often alter the dependence relationships among the agents during the simulation run, making plans less predictable.

	Traditional aging support networks	**Digitally enabled aging support networks**
goals	physical presence in traditional support networks subjects in intimate and effective zones play the main roles	physical and digital presence in social support networks subject in nominal and extended zones can play a relevant role
plans	more predictable	unplanned trajectories
actions	constrained by physical capabilities	viral diffusion of digital skills and capabilities,
resources	limited, costly, consumable	replicable, diffused

Table 1. Traditional vs digitally enabled aging support networks

For instantiating the architecture of simulation in the context of social support networks we draw on the previous works of Boissevain (1968) and Wenger (1997). The former provides a definition for six network circles: personal cell that comprise the closest friends and family members; intimate zone A (relatives and friends with frequent interactions); intimate zone B (friends and relatives with passive relationship, although emotionally important); effective zone (people important in a pragmatic sense); nominal zone (acquaintances that do not play an important role); extended zone (people linked through significant others). Wenger assigns a degree of involvement in "community groups" for each support network type, by taking into account the geographic distance between involved actors: (i) locally integrated (composed by close family members, friends and neighbours); (ii) wider community focused (composed mainly by friends and neighbours); (iii) local self-contained (the support is given mainly by neighbours and sometimes by relatives that do not live close to the older);

(iv) local family dependent (close family members with some neighbour); (v) private restricted (any informal support is absent).

Looking the aging support network with the taxonomy of Wenger, it is possible to observe how the geographic distance becomes less relevant in digitally enabled scenario, and taking into account the circles defined by Boissevain, also agents in nominal and external zone can play a significant role in supporting the older, bringing into his network some new digital capabilities or best practices, learned outside (and vice versa). The potential of the simulation run can provide insights for identifying the organizational form and hence to design the digital platform that better match the requirements of a specific aging support network. For example on the basis of the agents' behaviour it is possible to identify three organizational forms as defined by Shirky (2008): sharing, collaboration, and collective action.

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