
Embodied Participatory Simulations of Disease as an Entry Point for Network Analysis

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We have been working with a corporate partner to stabilize a flexible wearable-computing platform for embodied participatory simulations (Brady et al, 2015; 2016), involving hardware (electronic “badges”); software (a blocks-based authoring environment for creating programs that exploit the badges’ native functionality); and network infrastructure (including facilities for creating publish-and-subscribe services and for storing information needed for or produced through badge activities). This poster describes the first pilot of a new WiFi-enabled version of this full platform in a course in Human Geography for pre-service social studies teachers, at a large private university in the southeastern United States. Our motivation was to explore how embodied participatory simulations (Brady et al, 2017; Collella et al, 1998) could provide an accessible entry point to ideas of network theory for non-technical pre-service teachers. We asked, “How can playing out an interaction network through embodied role-play offer resources for participants to reason about the role of network structure in the spread of disease?”

Network theory offers a powerful set of tools to make sense of, among other things, (a) emergent phenomena that are illuminated by structures of groups that go beyond their spatial distribution, or (b) the way that groups’ structures are formed in interaction. These are powerful ideas for explaining complex systems, but they can be challenging to reason with. In connection with agent-based modeling, network analyses can offer exciting new insights on a variety of phenomena, including the spread of disease (Head et al, 2018; Vermeer et al, 2017).

Participatory simulations, or PartSims (Wilensky & Stroup, 1999a) have been an important tool for enabling groups to make sense of complexity through role-play, often supported by communications technology. In the context of agent-based modeling, NetLogo’s (Wilensky, 1999) HubNet module (Wilensky & Stroup, 1999b), and a web-based implementation entitled GbCC (Brady et al, 2018) enable virtual PartSims and other group-centered activity designs that make emergence accessible (Wilensky & Stroup, 1999a; 2000). Embodied participatory simulations (Brady et al, 2016; Colella et al., 1998; Klopfer, Yoon, & Perry, 2005) have developed in parallel with the virtual versions described above and are useful where physical enactment is an asset.

In a unit on the spread of disease and other social phenomena of dissemination and diffusion, the classroom group engaged in several simulations of social interactions, using NetLogo and GbCC. To foreground group structure and its influence on interactions, we used the badge platform to enable the group to build interaction networks with different structures and characteristics, supported by real-time visualization. As a group, we then reasoned about how disease or other phenomena would spread on these networks, using replays of the interaction dynamics, where one or more nodes of the network were chosen to start the simulation as “infected.”

In the first activity, students could interact with anyone else in the class, with the goal of finding out how many people shared a trait with them (a random number, 1-10). Each time they spoke with a classmate, their badges transmitted the interaction to a server, allowing a web-enabled NetLogo model to display the emerging network of interactions in real time (see Fig 1). The NetLogo model then allowed the interactions to be re-run virtually, with the option of supposing that one (or more) of the badges/participants began as infected.



Figure 1. Simulating social interactions with the badges. Right: a real time display of the network, here showing the final state, with the node-link representation centered on the most-connected node.

Questions arose about whether and how disease might propagate differently on different networks. In response, the class then ran two other scenarios: one where they could connect only with classmates who had at least one other class with them (left) and another where they could connect only with individuals who were “friends” on a social media platform.

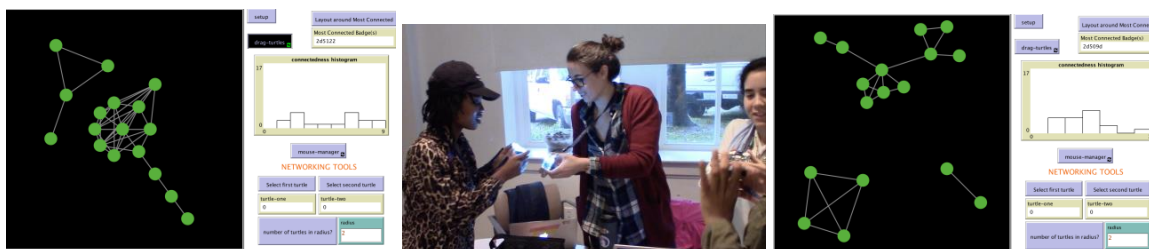


Figure 2. Creating different network structures. Left: two connected components; Right: three.

The first scenario produced a network with two connected components (corresponding to membership in distinct degree programs); the second, three (Fig 2). Running the spread of disease from a random node on the social-media defined network yielded the simulation below (Fig 3).

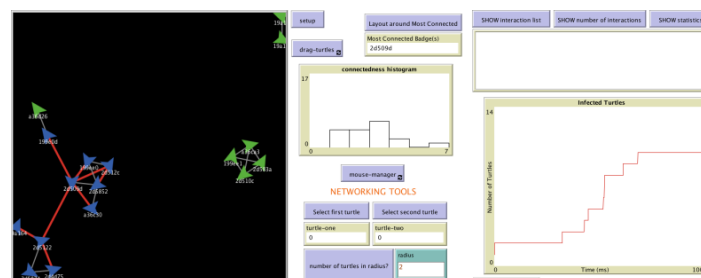


Figure 3. Disease spreading from a random node on the three-component network.

The badge-based activities provided a non-technical student group with a shared introductory experience with networking concepts and representations. Grounding the experience in familiar features of their lives (their programs of study and their social media use), they were able to make sense of concepts such as connectedness and network distance, as well as to appreciate the utility of these ideas in reasoning about disease spread. We argue that such activities can offer groups of learners shared experiences of connectedness and can create the need for key ideas in network theory. We further argue that the embodied nature of the simulations and the real-time visualization of the emerging network are valuable in making sense of node-link representations. Following on this successful pilot we are planning an implementation with high-school students of similar activities and activities with longer duration that unfold over entire days in the students' school environment.

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