Physics rules network dynamics

December 11 2009

Physicist Ginesta Bianconi charts complex networks with physics. Photo by Craig Bailey

(PhysOrg.com) -- When it comes to the workings of the Web, the brain, or a social network, physics finds universal truths.

Facebook, Google, and other expansive Internet sites share important characteristics with complex biological systems, says physicist Ginestra Bianconi—both contain a vast number and variety of linkages that can be better understood through network theory.

In particular, Bianconi's latest research focuses on modeling the evolution and dynamics of networks in different contexts: from the Internet to social interactions to neural networks.

"It turns out that there is almost an equivalence between complex systems and networks: there is no brain without links between neurons,

there is no society without social interaction between individuals," she says.

"Physics concepts and ideas play a crucial role in the understanding of the complexity of networks," she says. "In the last decade we have gained a deep understanding of the key structural properties of these networks, with important breakthroughs showing that some aspects of these networks are universal."

By "universal," Bianconi means that the same fundamental structural characteristics are shared by networks linking everything from Internet connections to protein interactions in the cell, to the network of researchers who cite each others' papers, to collaborations among scientists or musicians.

Bianconi's research attempts to quantify the randomness and the order present in complex networks with different structural characteristics, and she has found that universalities also play a crucial role for dynamic processes on networks.

In network physics, the same mathematical description might apply to the processes that yield a "winning" species in an ecological network or a "winning" search engine like Google in the cyber network that is the Internet, says Bianconi.

"Moreover these systems can be "mapped" on a quantum physics model, ultimately yielding better understanding of the networks involved," she says.

The newly hired assistant professor of physics joins Northeastern University from the University of Notre Dame, where she received her doctoral degree.

Bianconi says she was drawn to the physics of complex networks because it allows her to see unexpected universalities between different systems and phenomena, and because she was challenged to find out their underlying common mathematical framework. This year, she was drawn to Northeastern University because of the cutting-edge work being done on campus in the area of network science.

Bianconi has published widely, including two journal articles with Northeastern physicist Albert-Laszlo Barabasi, the director of the University's world-leading Center for Complex Network Research. Most recently, she coauthored "Assessing the Relevance of Node Features for Network Structure," which was published in the July 14 issue of the journal *Proceedings of the National Academy of Sciences*.

Provided by Northeastern University (news : web)