Integrating Computer and Natural Sciences to Explore the Structure and Dynamics of Complex Ecological Networks

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ABSTRACT

Ecological networks comprised of diverse species interacting within habitats describe iconic complex systems. Their nodes are dynamic, highly heterogenous and constantly evolving in response to their changing environment. Their feeding interactions are nonlinear therefore even more dynamic and very difficult to predict while remaining critical to the continued existence and evolution of the nodes. Their boundaries, somewhere between outer space and the earth's core, are extremely fuzzy and highly porous. Yet, ecological networks remain remarkably robust famously surviving asteroidal and anthropogenic catastrophes that destroy huge fractions of the nodes and interactions both directly and through profound often permanent alterations of the environment. Ecologists among many other scientists have long been perplexed as to how natural diversity and complexity manage to persist despite all these odds. Recent progress towards solving this puzzle employs network informatics, visualizations, and simulations that synthesize network structure and dynamics into mathematical models with a wide variety of parameters. Exploring these models demands that the parameters are both fit using rigorous informatics and also varied in innumerable combinations using efficient and powerful computer architectures. This presentation will describe the mechanics of this endeavor as well as several of the most interesting research results including the robustness enhancing roles of network architecture and organism's size and behavioral nonlinearities as well as network effects of species' loss and invasions. A particular future for such endeavors will also described with special attention to implications for general network science.