Algebra adds value to mathematical biology education

July 30 2009

As mathematics continues to become an increasingly important component in undergraduate biology programs, a more comprehensive understanding of the use of algebraic models is needed by the next generation of biologists to facilitate new advances in the life sciences, according to researchers at Sweet Briar College and the Virginia Bioinformatics Institute (VBI) at Virginia Tech.

In the paper, "Mathematical Biology Education: Beyond Calculus," which is featured in the July 31, 2009 issue of *Science*, VBI Professor Reinhard Laubenbacher and Sweet Briar College Mathematical Sciences Professor Raina Robeva highlight algebraic models as one of the diverse mathematical tools needed in the professional development of up-and-coming life scientists. Despite this critical need, the authors explain, algebraic models have played a less substantial role in undergraduate curricula than other methods.

Future generations of biologists will routinely use mathematical and computational approaches to develop and frame hypotheses, design experiments, and analyze results. Sound mathematical models are essential for this purpose and are currently used in the field of systems biology to understand complex biological networks. Two types of mathematical models, in particular, have been successfully used in biology to reproduce network structure and dynamics: Continuous-time models derived from differential equations (DE models) focus on the kinetics of biochemical reactions, while discrete-time algebraic models built from functions of finite-state variables focus on the logic of the connections of network variables. According to Laubenbacher and Robeva, while DE models have been included more often in undergraduate curricula integrating mathematics and biology, algebraic models should also be viewed as an important training component for students at all education levels.

"Discrete-time algebraic models created from finite-state variables, such as Boolean networks, are increasingly being used to model a variety of biochemical networks, including metabolic, gene regulatory, and signal transduction networks," says Laubenbacher. "Often, researchers do not have enough of the information required to build detailed quantitative models. Algebraic models need less information about the system to be modeled, making them useful for instances where quantitative information may be missing. All the work that goes into building them can then be used to construct detailed kinetic models, when additional information becomes available. In addition, algebraic models are much more intuitive than differential equations models, which makes them more easily accessible to life scientists."

Using algebraic models is a relatively quick, easy and reliable way for students to integrate mathematical modeling into their life sciences coursework. Creating algebraic models of biochemical networks requires only a modest mathematical background, which is usually provided in a college algebra course. Without the complexities involved in teaching students how to construct more complicated models, algebraic models make the introduction of mathematical modeling into life sciences courses more accessible for faculty members as well.

According to Robeva, "The exciting thing about algebraic models from an educational perspective is that they highlight aspects of modern-day biology and can easily fit in both the biology and mathematics curricula. At the introductory level, they provide a quick path for introducing biology students to constructing and using mathematical models in the context of contemporary problems such as gene regulation. At the more advanced level, the general study and analysis of such models often require sophisticated mathematical theories. This makes them perfect for inclusion into mathematics courses, where the biology can provide a meaningful framework for many of the abstract structures. As educators, we should actively be looking for the best ways to seize this opportunity for advancing mathematical biology."

Source: Virginia Tech (news : web)

Citation: Algebra adds value to mathematical biology education (2009, July 30) retrieved 25 April 2024 from https://phys.org/news/2009-07-algebra-mathematical-biology.html