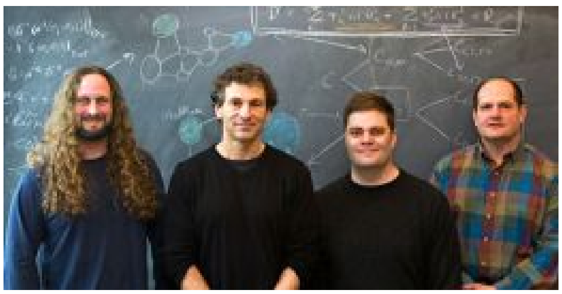
Researchers develop computational tool to untangle complex data

December 16 2008



ckmore (second from left) and his team developed the new PDM computational tool. (photo by Joseph Mehling '69)

(PhysOrg.com) -- A group of Dartmouth researchers have developed a mathematical tool that can be used to unscramble the underlying structure of time-dependent, interrelated, complex data, like the votes of legislators over their careers, second-by-second activity of the stock market, or levels of oxygenated blood flow in the brain.

The researchers named their tool the Partition Decoupling Method, and their study is published in this week's online issue of the *Proceedings of the National Academy of Sciences*. The authors are Gregory Leibon, Scott Pauls, and Daniel Rockmore with Dartmouth's Department of Mathematics, and Robert Savell from Dartmouth's Thayer School of Engineering.

"With respect to the equities market we created a map that illustrated a generalized notion of sector and industry, as well as the interactions between them, reflecting the different levels of capital flow, among and between companies, industries, sectors, and so forth," says Rockmore, the John G. Kemeny Parents Professor of Mathematics and a professor of computer science. "In fact, it is this idea of flow, be it capital, oxygenated blood, or political orientation, that we are capturing."

Capturing patterns in this so-called 'flow' is important to understand the subtle interdependencies among the different components of a complex system. The researchers use the mathematics of a subject called spectral analysis, which is often used to model heat flow on different kinds of geometric surfaces, to analyze the network of correlations. This is combined with statistical learning tools to produce the Partition Decoupling Method (PDM). The PDM discovers regions where the flow circulates more than would be expected at random, collapsing these regions and then creating new networks of sectors as well as residual networks. The result effectively zooms in to obtain detailed analysis of the interrelations as well as zooms out to view the coarse-scale flow at a distance.

Rockmore explains that the Partition Decoupling Method takes a different approach that other tools designed to tease out how complex systems behave. "The PDM is not strictly hierarchical," says Rockmore. "It instead details the interaction between a number of different elements of the system. PDM places no constraint on interconnectivity."

The researchers applied the PDM to the equities market, a system rich in numerical data, as well a complex web of interdependent markets, industries, and currencies. The PDM proved robust, revealing both known structures and patterns and new structures that came to light with the new analysis.

"We think this tool can be useful, when applied in the financial realm, to portfolio and risk management," says Rockmore. "We expect similar results as it is applied to different complex systems like the brain, or even the collections of brains that are societies."

Source: Dartmouth College

Citation: Researchers develop computational tool to untangle complex data (2008, December 16) retrieved 19 April 2024 from https://phys.org/news/2008-12-tool-untangle-complex.html

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