

# Professor quantifies how 'one thing leads to another'

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(Phys.org) —"One thing led to another," people often say. Events, discoveries and relationships are triggered by something previous. The iPhone case was designed only because the iPhone was invented first. A song became popular only after someone liked it.

Mathematicians always want to quantify things, and Steven Strogatz, Cornell's Jacob Gould Schurman Professor of Applied Mathematics, is trying to quantify the commonsense concept of "correlated novelties" – that one new thing sometimes (but not always) triggers another. He and three researchers from Italy's Sapienza University, where he spent three months on sabbatical leave, published a paper in *Scientific Reports* July 31 on their first crack at it.

"This concept of correlated novelties had only been phrased in verbal or conceptual terms," Strogatz said. "It seemed like a really intriguing idea, with room for creativity to make it testable."

Correlated novelties are everywhere: in economics, or perhaps most obviously, in [evolutionary biology](#), where traits evolve over time from a cascade of tiny events.

In this era of big data and supercomputing, going back to find patterns in outcomes is easier than ever. Strogatz and his colleagues used four data sets as test cases, each consisting of a sequence of elements ordered in time: texts, where the elements are words, and the novelty occurs when a word appears for the first time; online music, where the novelty is the

first time a listener hears a song or artist; Wikipedia, where novelties are the first edit of a given wikipage; and social annotation in tagging sites, where novelties are the introduction of a new tag.

The researchers quantified the rate at which novelties occurred by focusing on the growth of distinct elements in an ordered sequence. They discovered that the rate at which novelties occur decreases over time.

They proposed a simple mathematical model that mimics the process of exploring a physical, biological or conceptual space that enlarges whenever a novelty occurs, according to the paper. The model is based on Polya's Urn, familiar to mathematicians. An urn filled with black and white balls churn like lottery balls; whenever one color is picked, more of the same color are added back. That enhances the likelihood of that original color being picked at the next turn.

The concept has an echo of the familiar, Strogatz says. For example, the urn could be considered a simplification of the "rich get richer" concept – that socioeconomic stratification isn't random, but strongly correlated with previous events.

Such insights hint at the possibility of a sophisticated [mathematical model](#) building on the one proposed to address an endless list of human problems in economics, biology and epidemiology, to name a few. For example, applying the model to 100 years of influenza data, epidemiologists could perhaps learn to predict how the flu will spread going forward, Strogatz said.

**More information:** "The Dynamics of Correlated Novelties," *Scientific Reports*, 2014.

Provided by Cornell University

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