

FAQ : Networks to describe the Universe

[This thought-provoking material was put together by Lucas Valenca. Comments welcome!]

Professor +thinkers,

I ran into this study done by the University of California San Diego (UCSD) mathematics department in affiliation with the UCSD Supercomputer Center that postulates: the evolution and expansion evident in the physical universe resembles complex network growth patterns observed in the Internet, the brain, and social networks. I'm not sure if I accept it yet but it's validation for Prof. Caviness' project. I'm not sure what template is used in their research but they use a similar language in describing their framework, like nodes, causal networks, and dimensionality.

<http://www.nature.com/srep/2012/121113/srep00793/full/srep00793.html#affil-auth>

PDF <http://www.nature.com/srep/2012/121113/srep00793/pdf/srep00793.pdf>

"Physics explains complex phenomena in nature by reducing them to an interplay of simple fundamental laws. This very successful tradition seems to experience certain difficulties in application to complex systems in general... where it remains unclear if there exists some unique universal laws explaining a variety of structural and dynamical similarities found in many different real networks."

"The main physical motivation for quantum gravity is that at the Planck scale ($l_P \sim 10^{-35}$ meters and $t_P \sim 10^{-43}$ seconds), one expects spacetime not to be continuous but to have a discrete structure, similar to ordinary matter, which is not continuous at atomic scales but instead is composed of discrete particles. The mathematical fact that the structure of a relativistic spacetime is almost fully determined by its causal structure alone motivates the causal set approach to quantum gravity. This approach postulates that spacetime at the Planck scale is a discrete causal set, or *causet*. A causet is a set of elements (Planck-scale "atoms" of spacetime) endowed with causal relationships among them. A causet is thus a network in which nodes are spacetime quanta, and links are causal relationships between them."

"In 1998 the expansion of our universe was found to be accelerating. Positive vacuum energy, or *dark energy*, corresponding to a positive cosmological constant Λ in the Einstein equations, is currently the most plausible explanation for this acceleration, even though the origin and nature of dark energy is one of the deepest mysteries in contemporary science. Positive Λ implies that the universe is asymptotically (at late times) described by de Sitter spacetime."

"The degree distributions in some complex networks deviate from clean power laws, the exponents of these power laws vary a lot across different real networks, and so do clustering, correlation, and many other structural properties of these networks. Therefore it may seem unlikely that de Sitter causets can

model the full spectrum of structural diversity observed in complex networks."

But what if Prof. Caviness' Sequential Substitution Systems enumeration algorithms can capable of this? The study suggests features of causal spacetime fabric growth as in our physical universe parallels not just other systems or behaviors in the physical world but real complex networks even those in social and biological domains.

Apparently UC San Diego's Supercomputer Center will collaborate with researchers; they have a Center for Large-scale Data Systems Research.

"SDSC also offers hands-on training in computational thinking, high-performance computing, and big data exploration to students and researchers at nearly every level of sophistication. SDSC "Training" for research professionals focuses on building their skills to use high-performance computing, data-intensive computing, and data analytics within their own research disciplines; from neuroscience and geophysics to the humanities, arts and social sciences."

But I doubt they would hand over a super, mega high-processing quantum computer for us to run SSS cases on.

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