August 2016 Complexity Community Sharing Session

19 Aug 2016 (Fri) 11:00am-01:00pm

Seminar Room 102

(opposite Learning Hub), Blk 1 Innovation Centre, Level 1
16 Nanyang Drive, Singapore 637722

On the Origin of Power Laws in History Dependent Complex Systems

Prof. Stefan Thurner

Where do power laws come from? There exist a handful of famous mechanisms that dynamically leadto scaling laws in complex dynamical systems, including preferential attachment processes and self-organized criticality. One extremely simple mechanism has so-far been overlooked that applies for processes that are history dependent. We present a mathematical theorem that states that every stochastic process that reduces its number of possible outcomes over time, leads to power laws in the frequency distributions of that so-called sample-space-reducing process (SSR). We show that targeted diffusion on networks is exactly such a SSR process, and we can thus understand power law visiting distributions are so ubiquitous in nature. We show examples where SSR processes are able to explain the origin of scaling laws, one being the famous Zipf law in word frequencies.

Biography: *Stefan Thurner is full professor for Science of Complex Systems at the Medical University of Vienna, where he chairs Section for Science of Complex Systems. Since 2007 he is external professor at the Santa Fe Institute, since 2010 he is a part-time senior researcher at IIASA. With his engagement with the Santa Fe Institute - he shifted his focus from theoretical physics to biological and complex systems, which are now his main scientific areas. Since 1995 Thurner has published more than 170 scientific articles in fundamental, applied mathematics complex systems, life sciences, economics and lately in social sciences. He holds 2 patents.*

When is Simpler Thermodynamically Better?

Dr. Andrew J. P. Garner

Living organisms capitalize on their ability to predict their environment to maximize their available free energy, and invest this energy in turn to create new complex structures. Is there a preferred method by which this manipulation of structure should be done? Our intuition is "simpler is better," but this is only a guiding principal. Here, we substantiate this claim through thermodynamic reasoning. We present a new framework for the manipulation of patterns (structured sequences of data) by predictive devices. We identify the dis+sipative costs and how they can be minimized by the choice of memory in these predictive devices. For pattern generation, we see that simpler is indeed better. However, contrary to intuition, when it comes to extracting work from a pattern, any device capable of making statistically accurate predictions can recover all available energy.

Biography:
Andrew Garner is a post-doctoral research fellow at the Centre for Quantum Technologies, National University of Singapore. His current research lies at the intersection between quantum theory and complexity science, where he uses techniques from both fields to examine why the universe is the way it is. He finished his DPhil in Atomic & Laser Physics at the University of Oxford in 2015, where he focused on the foundations of quantum physics, and the fundamentals of information thermodynamics.

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