Complexity Community Sharing Session

6 Dec (Wed) 11.00am – 1.00pm
Seminar Room 102
Blk 1 Innovation Centre, Level 1 (opposite The Hive), NTU
16 Nanyang Drive, Singapore 637722

Combinatorial Evolution & its Statistics

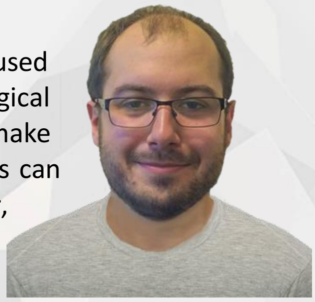
Prof. Stefan Thurner

Evolutionary processes are far from being understood mathematically. I will try to make clear why this is so and propose a conceptually simple model that mimics key features of combinatorial evolution. I will demonstrate that the model is able to predict empirical facts from biological and economic evolutionary systems.

In particular I will show that combinatory evolutionary systems are self-organized critical and that it becomes possible to compute its statistical properties. Also I will demonstrate that the model is able to predict the diversification of products that are produced in national economies over time.

***Stefan** is full professor for Science of Complex Systems at the Medical University of Vienna, where he chairs Section for Science of Complex Systems. He is external professor at the Santa Fe Institute, senior researcher at IIASA, and president of the Complexity Science Hub Vienna. He obtained a PhD in theoretical physics from the Technical University of Vienna and a PhD in economics from the University of Vienna. He held postdoc positions at Humboldt Universität zu Berlin and Boston University before joining the faculty of the University of Vienna and later Medical University. His habilitation is in theoretical physics. Stefan started his career with contributions to theroretical particle physics and gradually shifted his resarch focus to the understanding of complex systems. He published more than 200 scientific articles in fundamental physics, applied mathematics, network theory, evolutionary systems, life sciences, network medicine, gene regulatory networks, economics and finance, systemic risk and lately in social sciences. He holds 2 patents. His work has been covered by media such as the New York Times, BBC world, Nature, New Scientist, Physics World and is featured in more than 400 newspaper, radio and television reports.*

Occam's Vorpal Quantum Razor: Using Quantum Devices to Efficiently Model Complex Continuous-time Stochastic Processes



Dr. Thomas Elliott

Continuous-time stochastic processes are omniprescent across the sciences. They are used to model a rich & diverse range of systems, such as financial time-series & biological processes. Given their broad applicability, our ability to study, simulate, and make predictions using such models is of great import. However simulations of such models can become highly resource-intensive, in part due to their continuous nature. In particular, the information that must be tracked about the past of the process typically diverges with increased precision.

Quantum technologies promise enhanced computations by exploiting the fascinating quirks of quantum physics. These enhancements can be characterised and quantified by information-theoretic notions of complexity. Recently a new type of quantum advantage has been discovered, wherein quantum devices can track and simulate stochastic processes whilst retaining less past information than even the optimal classical models. We extend these results into the continuous-time domain, providing a systematic construction for such quantum models of continuous-time processes. We show that the memory savings can be unbounded, allowing quantum simulators of continuous-time processes to achieve arbitrarily fine precision with finite memory, sidestepping the limitations suffered by their classical counterparts.

***Thomas Elliott** is a Research Fellow at Nanyang Technological University working under Mile Gu in the Quantum & Complexity Science Initiative. He was awarded his DPhil in Atomic & Laser Physics in 2016 from University of Oxford, where he worked on various topics on quantum simulation & measurement of many-body systems. His current research interests focus on the enhancements offered by quantum technologies for the statistical sciences, esp. for simulating continuous-time stochastic processes, and developing protocols for near-future devices.*

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Register here.

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