Complexity Community Sharing Session

10 JAN (WED) 11.00am – 1.00pm

Seminar Room 102

Blk 1 Innovation Centre, Level 1 (opposite The Hive), NTU
16 Nanyang Drive, Singapore 637722

A fast flow-based algorithm for creating density-equalizing map projections

Dr Michael Gastner

Cartograms are maps that rescale geographic regions (e.g. countries, districts) such that their areas are proportional to quantitative demographic data (e.g. population size, gross domestic product). Unlike conventional bar or pie charts, cartograms can represent correctly which regions share common borders, resulting in insightful visualizations that can be the basis for further spatial statistical analysis. Developing an algorithm that can quickly transform every coordinate on the map while generating recognizable images has remained a challenge. I will introduce a flow-based algorithm that accurately scales all areas, correctly fits the regions together and produces attractive graphics. Compared to previous methods, the equations are numerically easier to solve and allow straightforward parallelization so that the calculation takes only a few seconds even for complex and detailed input. We demonstrate the use of our algorithm with applications to the 2016 US election results, the gross domestic products of Indian states and Chinese provinces, and the spatial distribution of deaths in London between 2011 and 2014.

Michael Gastner received his PhD in physics from the University of Michigan. He was postdoctoral fellow at the Santa Fe Institute, the Computer Science Department of the University of New Mexico and the University of Oldenburg's Institute for Chemistry and Biology of the Marine Environment. After a Junior Research Fellowship at the Mathematics Department at Imperial College London and a lectureship in Engineering Mathematics at the University of Bristol, he spent two years at the Hungarian Academy of Sciences in Budapest. He is currently Assistant Professor for Mathematics, Computer Science and Statistics at Yale-NUS College in Singapore.

Quantum Precision: Unbounded memory advantage in simulating complex systems using quantum mechanics

Dr. Andrew Garner

The world is full of processes that are best modelled by the evolution of real numbers. However, simulating the stochastic evolution of real quantities on a digital computer requires a trade-off between the precision to which these quantities are approximated, and the memory required to store them. The statistical accuracy of the simulation is thus generally limited by the internal memory available to the simulator. In this presentation, using tools from complexity theory, and particularly computational mechanics, I shall show that quantum information processing allows the simulation of stochastic processes to arbitrarily high precision at a finite memory cost. This demonstrates the unbounded memory advantage that a quantum computer can exhibit over its best possible classical counterpart when used for stochastic simulations.

Andrew Garner is a post-doctoral research fellow at the Centre for Quantum Technologies at the National University of Singapore. In his DPhil thesis (Physics, University of Oxford, 2015), he focused on the foundations of quantum information theory – considering how interference phenomena could be generalized beyond quantum theory. Since then, he has worked on fundamental theories of information thermodynamics, and especially on the intersection between quantum theory and complexity science.

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

Register here.

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