



## Research Seminar

# Physics-inspired dynamical systems for combinatorial optimization — when can analog solvers address discrete problems?

Speaker: Dr. Daniel EBLER

Date: January 31, 2024 (Wed)

Time: 16:30 (HKT)

Venue: Room 328, Chow Yei Ching Building, HKU

### Abstract

Combinatorial optimization problems lie at the core of numerous industrial applications, encompassing traffic congestion models, wireless decoding problems, fabrication of meta-materials, and integrated circuit design. These problems are NP hard or complete, such that finding solutions for problems large in scale or restricted by run-times have posed immense challenges. Recent developments in analog solvers have promoted the use of dynamical systems as a way to address combinatorial optimization problems. Notably, such heuristics has celebrated success both with hardware implementations of the related physical systems, as well as simulations thereof on conventional hardware such as GPUs and FPGAs. The underlying idea of such solvers is to utilize coupled physical systems, such as oscillator networks, to encode an optimization problem into the interaction pattern. Appropriate external control then directs the system evolution towards a stable configuration of the system which yields the solution of the problem. However, it has remained unclear how accurate such analog approaches can fundamentally be, given the discrete nature of the optimization. In this talk, we introduce Ising machines as a novel heuristic paradigm towards large-scale optimization and discuss recent developments and open challenges in the field. We further present the first results on accuracy of related analog solvers, which allows to formulate a sufficiency criterion on exact solvability. The results follow from bifurcation analyses of the system evolution and motivate alternative hybrid approaches to further boost convergence speed and accuracy.

### About the Speaker:

Daniel Ebler graduated from ETH Zurich in Physics and obtained his PhD at the University of Hong Kong. He held a permanent position as Senior Research Associate at SUSTech and worked at The University of Oxford as a long-term academic visiting scholar. Since 2020, Dr. Ebler has held the position of Principal Researcher at Huawei Research in Hong Kong, where he established the quantum computing and physics-inspired optimization group. His research interests include physical systems for optimization, quantum computing and machine learning, and dynamical systems, among others.

**All are welcome!**

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