Brain-inspired and energy efficient solutions to hard optimization problems.

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Optimization problems are ubiquitous in a wide range of technological and industrial applications, from efficient scheduling of package delivery to robotic control to drug discovery. Order of magnitude improvements in the energy efficiency of solving optimization problems have thus the potential to make computing systems more sustainable and environmentally friendly.

In this talk, I will present optimization algorithms and solvers developed for Intel's Loihi 2 research chip, an event-driven, massively and fine-grained parallel hardware inspired by the efficiency of the neural dynamics of biological brains (neuromorphic). Benchmarking results on those solvers show how Loihi enables a competitively fast solution to constraint satisfaction, quadratic unconstrained binary optimization and quadratic programming problems, with orders-of-magnitude advantage in energy consumption when compared with conventional solvers running on standard CPU architectures. These neuromorphic algorithms take the form of a network of distributed discrete dynamical systems that communicate asynchronously through small binary or integer messages. The global dynamics of such event-driven algorithms explore the state space defined by the input problem simultaneously minimizing a quantity defined by the problem's objective function and maximizing the satisfaction of requirements defined by the problem constraints. The spatiotemporal sparsity resulting from such a computing paradigm is what enables the remarkable energy efficiency of neuromorphic optimization.