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Algorithms are the recipes computers follow to solve problems. As we seek to analyse ever-larger data sets, we need algorithms that can answer complex questions about them extremely quickly. Designing such fast algorithms, especially for data with network structure, is the core of Rasmus Kyng's research. Network structures abound: think of Internet traffic, transportation, logistics, social ties, and physical systems such as electric grids or even heat flows through a physical material.

Prof. Kyng's group has created radically faster algorithms for many computational problems on networks. As theoretical computer scientists, the group begins by formally proving that efficient algorithms exist using mathematical models and formal analyses of the algorithmic process itself. When this succeeds, the group works on turning these theoretical algorithms into practically useful software.

Electrical flows

A theoretical breakthrough in the early 2000s showed that electrical flows could be computed quickly, at least in theory. Yet usable code remained elusive. Prof. Kyng uncovered simple, practical algorithms and proved why they work using random matrix theory that originated in quantum mechanics.

Logistical networks

Assignment tasks—matching workers with jobs, taxis with riders, or data requests with servers—and combinatorial flow tasks—scheduling trains, routing digital traffic, or coordinating currency trades—all fit a broad template studied by algorithm designers. Together with collaborators, Prof. Kyng introduced a striking new framework that merges gradient descent techniques with novel network data structures, yielding far faster solutions to all these problems—in theory. His team is now focused on turning these advances into high-performance tools for real-world use.