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Polychronous Oscillator Computing to Solve Optimization Problems

Stanford researchers have developed a fast and energy-efficient computational platform-based on the Potts Machine model that can solve large-scale, combinatorial optimization problems. This computing system is made up of a programmable, reconfigurable array of superharmonic injection-locked, coupled oscillators that compute solutions to combinatorial optimization problems in real-time. This technology can enable orders-of-magnitude improvements in the energy efficiency and computational speed of solving combinatorial optimization problems.

The computations that make modern technology such as the Internet of Things and machine learning possible have a high energy demand. As technology evolves, it will become increasingly important to develop computers with improved energy efficiency and computing capability. Quantum and cryogenic computing are potential alternatives to traditional computing, but they require elaborate cooling systems, limiting their portability and widespread adoption. This invention is fast, energy-efficient, and can be implemented in CMOS circuit technology using existing manufacturing techniques.

Stage of Development
Proof of concept

Applications

- **Accelerator chip** for solving combinatorial optimization problems in fields such as:
  - Logistics
  - Navigation (autonomous vehicles)
  - Finance
  - Drug discovery

- **Industrial and consumer robotics**
- **Cloud-based service** that enables users to remotely program and solve large-scale combinatorial optimization problems on remote hardware
- **Powerful, energy-efficient local computing**

Advantages

- **Miniature size, small form factor**
- Ease of manufacturing
- Compatible with existing infrastructure, such as standard CMOS foundries
- **Operates at room temperature**
- Low power consumption
- Scalability to solve large problems and simple routing
- **Speed** to solve for robust solution

Publications

- R. L. Smith and T. H. Lee, "Polychronous Oscillatory Cellular Neural Networks for Solving Graph Coloring Problems," IEEE Open Journal of Circuits and Systems, vol. 4, pp. 156-164, 2023.

Innovators

- Richelle Smith
- Thomas Lee

Licensing Contact

Evan Elder

Senior Licensing Associate

Email