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LAB TALK

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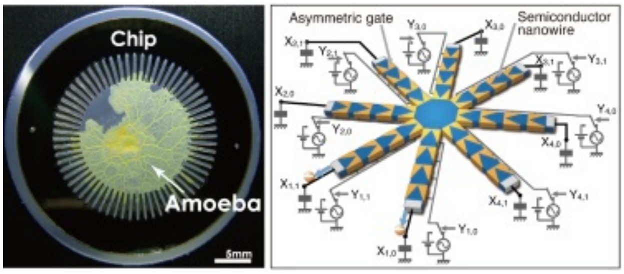
The wisdom of amoeba outperforms artificial intelligence

An amoeboid organism exhibits sophisticated computing capabilities. The shape-changing dynamics of such an organism involves stochastic fluctuations. It is comparable with the trial-and-error process, which is often the most efficient way to search for a solution to computationally demanding problems. Reporting in *Nanotechnology* (http://iopscience.iop.org/0957-4484/26/23/234001/article), researchers propose a nature-inspired nanoarchitectonic computing system. They extract essential spatiotemporal dynamics that allow an amoeboid organism to solve a computationally demanding problem and adapt to its environment.



(http://images.iop.org/objects/ntw/journal/14/6/4/figure1.jpg)

Amoeba-based computer (left) and representation of its nanodevice (right). (http://images.iop.org/objects/ntw/journal/14/6/4/figure1.jpg)

Researchers have shown that the trial-and-error process can be mimicked by utilizing noisy behaviour in a nanowire device. This solves the complex combinatorial optimization problem more quickly than using a well-known man-made search method.

True slime mold

A plasmodium of true slime mold *Physarum polycephalum* provides an intriguing research subject to investigate the competitiveness of the computing principles of biological systems. Despite lacking a central nervous system, a single-celled amoeboid organism shows a sophisticated ability to conduct decentralized information processing through its spatiotemporal oscillatory dynamics.

Electrical Brownian ratchets

A multidisciplinary team, including researchers from the Tokyo Institute of Technology and Hokkaido University in Japan collaborate. They extract the essential spatiotemporal dynamics through which the organism solves problems. This is implemented using a network of nanowire devices called electrical Brownian ratchets (EBRs).

Solving the ‘satisfiability problem’

They utilise fluctuations generated from the thermal energy in EBRs to search for a solution to the ‘satisfiability problem’ (SAT). This is one of the most fundamental constraint satisfaction problems. Investigations reveal that this amoeba-inspired SAT solver dramatically outperforms a conventional stochastic search algorithm commonly known in the field of artificial intelligence.

Solution-searching engines

Rapid methods that are capable of solving the SAT could be developed to create general-purpose solution-searching engines. Applications of this are wide ranging, including model checking, planning, scheduling, and design. These fields are closely related to domains such as software/hardware verification for designing computer processors and network protocols. In addition to planning for controlling mobile explorers, and reasoning for making optimal decisions in the area of electronic commerce.

Quantum computing

Recently, attention has been focused on new computing paradigms that are distinguishable from the conventional Turing-Neumann paradigm *i.e.* conventional digital computers conducting all tasks by iterating serial single-bit updating operations. Quantum computing paradigms exploit the parallel nature of a quantum superposition. Requiring elaborate equipment for controlling the quantum coherence, they are thereby fit for use in enterprise applications.

The power of collective wisdom

Brain-inspired paradigms, including a neural network and deep learning, accumulate information from past experiences and are applied to pattern recognition tasks. These do not overlap with the above-mentioned SAT applications. The amoeba-inspired paradigm conducts a trial-and-error search for SAT applications without the requirement of experienced knowledge. When implemented using a nanodevice, it is advantageous in terms of energy-efficiency, compactness, portability, and mass production. This allows the exploitation of the power of collective wisdom.

More information about this research can be found in the journal *Nanotechnology* **26 234001** (http://iopscience.iop.org/0957-4484/26/23/234001/article). This article forms part of the *Nanotechnology* Focus on Creating Novel Materials on the Basis of Mathematics and Nanoarchitectonics (http://iopscience.iop.org/0957-4484/focus/Focus-Creating-novel-materials-on-the-basis-of-mathematics-and-nanoarchitectonics).

Further reading

Can we build a computing device that works without any energy input? (May 2015) (http://nanotechweb.org/cws/article/lab/61273)
Memcapacitors could make our computers faster (June 2014) (http://nanotechweb.org/cws/article/lab/57674)
Kubo response theory applied to memristive, memcapacitive and meminductive systems (July 2013) (http://nanotechweb.org/cws/article/lab/54103)

About the author

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