

# News Release

FOR IMMEDIATE RELEASE

## Hitachi develops CMOS annealing technology "relaxed MA" for supporting optimization tasks with continuous variables

*Greater efficiency and precision in tasks such as reinsurance portfolio design in case of a large-scale disaster, or logistics planning*

**Tokyo, June 6, 2024** – Hitachi, Ltd. (TSE: 6501) has developed a new CMOS annealing technology, "relaxed MA," capable of optimization calculation using continuous variables (any decimals between 0 and 1)<sup>\*1</sup> in addition to the binary variables (1 or 0) possible up to now, as a key technology for solving large-scale, complex problems of society. Support for continuous variables will make it possible to solve larger-scale combinatorial optimization problems<sup>\*2</sup> with high precision.

The effectiveness of the new technology was verified by applying it to a reinsurance portfolio optimization task<sup>\*3</sup> assuming a large-scale disaster with compound damage causes. The results confirmed the ability to perform detailed and high-precision portfolio calculation of the expected revenue amounts in 1 yen increments, for ten times as many insurance contracts as with earlier technology.

Hitachi plans to make use of this technology in other applications besides reinsurance portfolio design, including efficient power grid operation accounting for supply-demand balance, optimization of sales promotion measures in e-commerce, and improving efficiency of logistics planning, thereby contributing to the solution of various problems facing customers and society.

The results of this development project are to be presented in part at Adiabatic Quantum Computing (AQC) 2024, being held in Glasgow, UK from June 10 to 14, 2024.

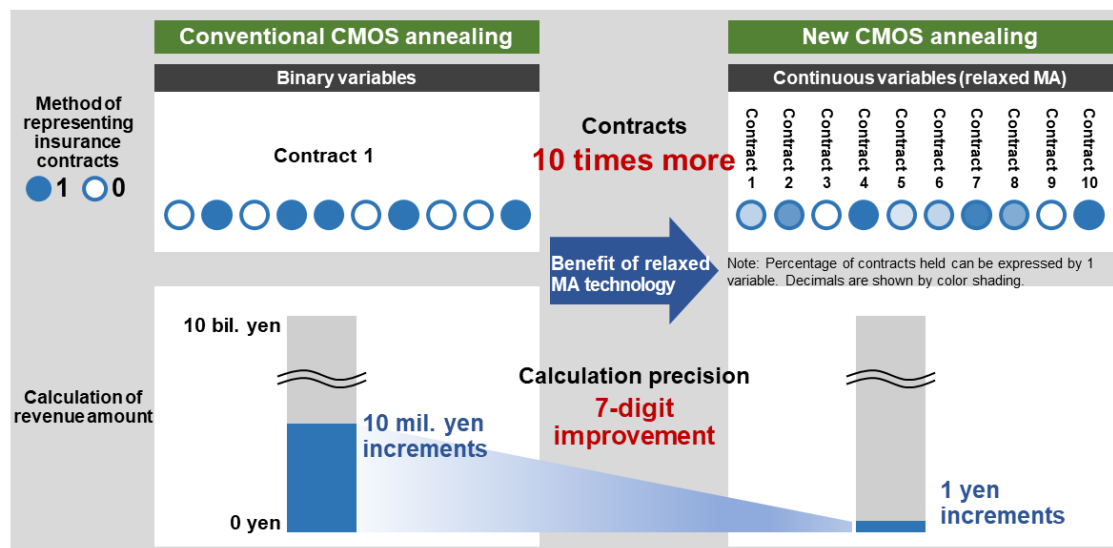


Figure 1. Effectiveness for reinsurance portfolio optimization (when expressing percentage of contracts held to three significant decimal figures)

\*1 Continuous variable: A variable that differs from a binary variable, expressed by 0 or 1 only, in being able to represent 32-bit or 64-bit floating decimal points between 0 and 1.  
 \*2 Combinatorial optimization problem: A problem seeking to determine the value (combination) of variables that optimizes a certain indicator (value) from among many different options under various constraints.  
 \*3 Reinsurance portfolio optimization task: The task of designing a balanced risk portfolio that disperses multiple risks held by an insurance company by means of reinsurance contracts.

#### ■ Hitachi initiatives up to now

New computing technology such as quantum computing has given rise to expectations in recent years that solutions to various problems of customers can be found by solving complex and large-scale combinatorial optimization problems.

In 2015, Hitachi developed a computing technology called CMOS annealing, which enables fast calculation by specialization to optimization problems. Then in 2019, Hitachi developed Momentum Annealing (MA)<sup>\*4</sup> as an algorithm using GPUs<sup>\*5</sup> for parallel processing to achieve high-speed calculation of fully connected problems with 100,000 variables. This technology was provided to customers starting in 2022 as CMOS annealing cloud service.

<sup>\*4</sup> [Expansion of CMOS Annealing Technology with an Aim of Providing Better Combinatorial Optimization Solutions That Meet Customer Requests](#) (October 18, 2019).

<sup>\*5</sup> GPU (Graphics Processing Unit): A computing device or processor specialized for real-time image processing. It performs scientific calculations faster than a CPU and with better energy efficiency.

#### ■ Background and issues leading to the development

In the case of Momentum Annealing (MA) developed in 2019, binary (1 or 0) variables were used as variables for solving combinatorial optimization problems. These were used to represent either “select” (1, i.e., 100%) or “not select” (0, i.e., 0%), for example, regarding the object of optimization. Since, however, it becomes necessary to perform calculations using multiple binary variables when optimizing decimals (percentages) that cannot be expressed by 1 or 0, the number of binary variables needed grows larger the greater the number of decimal digits (precision) demanded by the customer. In the case of financial product portfolio optimization, for example, to express to three significant decimal figures the percentage of various held contracts, the number of binary variables needed is approximately ten times the number of contracts. Increasing the number of significant figures in calculations thus limits the number of contracts, while an increase in number of contracts limits the number of significant decimal digits, making it difficult to use this approach for optimizing a large portfolio with high precision.

#### ■ Advantages of the newly developed “relaxed MA” technology

Hitachi expanded CMOS annealing algorithm and developed “relaxed MA” technology to make it possible calculations using continuous variables to express decimals, and further that uses parallel processing by GPUs for high-speed optimization calculations. Employing these technologies in financial product portfolio optimization, it has become possible to express with one continuous variable the percentage held of one contract. As a result, a reinsurance portfolio optimization problem applied to a vast number of insurance contracts in case of a large-scale disaster with compound damage causes can be solved with high speed and high precision.

Working with customers to verify the effectiveness of the new technology, we confirmed that with portfolio calculations for approximately ten times more contracts than earlier, the expected revenue amounts can be calculated in 1 yen increments, for very fine precision.

#### ■ Looking ahead

Hitachi has incorporated CMOS annealing applying “relaxed MA” in a cloud service and is offering it to customers. By having customers make use of CMOS annealing cloud service in various domains, we will contribute to solving various problems faced by customers and society, including the creation of work shifts under complex constraints, and making logistics planning more efficient and precise.

#### ■ About CMOS annealing cloud service

<https://www.hitachi.com/New/cnews/month/2022/10/221003b.html>

- End -

**About Hitachi, Ltd.**

Hitachi drives Social Innovation Business, creating a sustainable society through the use of data and technology. We solve customers' and society's challenges with Lumada solutions leveraging IT, OT (Operational Technology) and products. Hitachi operates under the 3 business sectors of "Digital Systems & Services" – supporting our customers' digital transformation; "Green Energy & Mobility" – contributing to a decarbonized society through energy and railway systems, and "Connective Industries" – connecting products through digital technology to provide solutions in various industries. Driven by Digital, Green, and Innovation, we aim for growth through co-creation with our customers. The company's revenues as 3 sectors for fiscal year 2023 (ended March 31, 2024) totaled 8,564.3 billion yen, with 573 consolidated subsidiaries and approximately 270,000 employees worldwide. For more information on Hitachi, please visit the company's website at <https://www.hitachi.com>.

**Media Contact:**

Hitachi, Ltd.

Research & Development Group

<https://www8.hitachi.co.jp/inquiry/hitachi-ltd/hqrd/news/en/form.jsp>

■ For Reference

Details of the newly developed “relaxed MA” technology

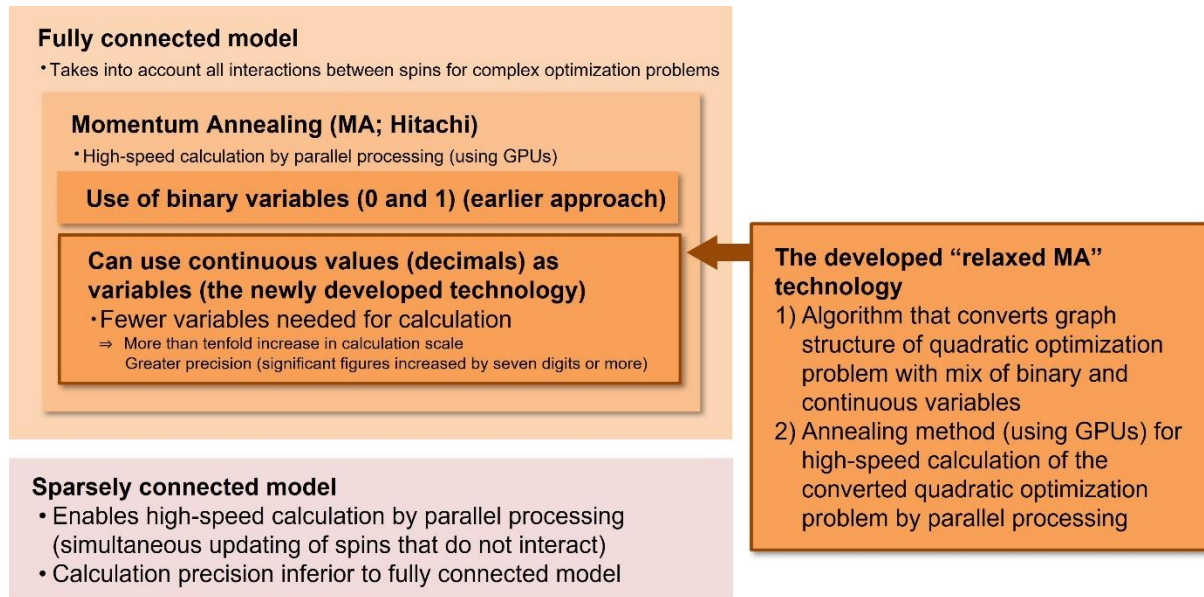


Figure 2. Using CMOS annealing to solve combinatorial optimization problems

1. Algorithm that converts graph structure of quadratic optimization problems with mix of binary and continuous variables

An algorithm was developed that converts the graph structure of a quadratic optimization problem containing a mix of binary variables which represent only 0 and 1 and continuous variables which represent any decimals between 0 and 1 to a quadratic optimization problem consisting only of continuous variables, and finding the solution to the latter. The validity of the algorithm was also verified mathematically. Since this algorithm can represent a problem using fewer variables than earlier, it can solve complex optimization problems with high speed and high precision.

2. Annealing method for high-speed calculation of the converted quadratic optimization problems by parallel processing

An annealing method was developed to perform calculation by parallel processing of the quadratic optimization problem generated by the above algorithm, consisting only of spins corresponding to continuous variables. Using this method, updating of the variables on one side of the complete bipartite graph consisting of continuous variables generated by the above algorithm (the variables expressed by  $x$  or  $y$  in Figure 3) is performed by fast parallel processing on GPUs. Compared to the number of variables in the fully connected graph consisting of binary variables, in a problem with  $N$  variables, the calculation time for updating all variables can be shortened to as little as  $2/N$  times, for high speed calculation of optimization problems.

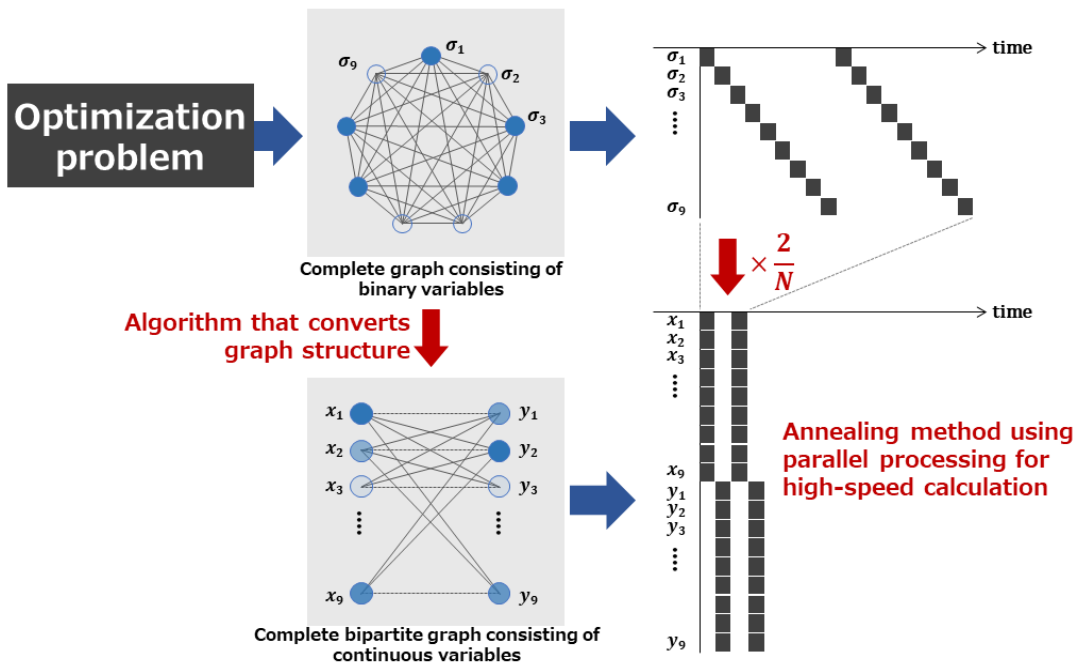


Figure 3. Overview of the developed “relaxed MA” technology

---

Information contained in this news release is current as of the date of the press announcement, but may be subject to change without prior notice.

---