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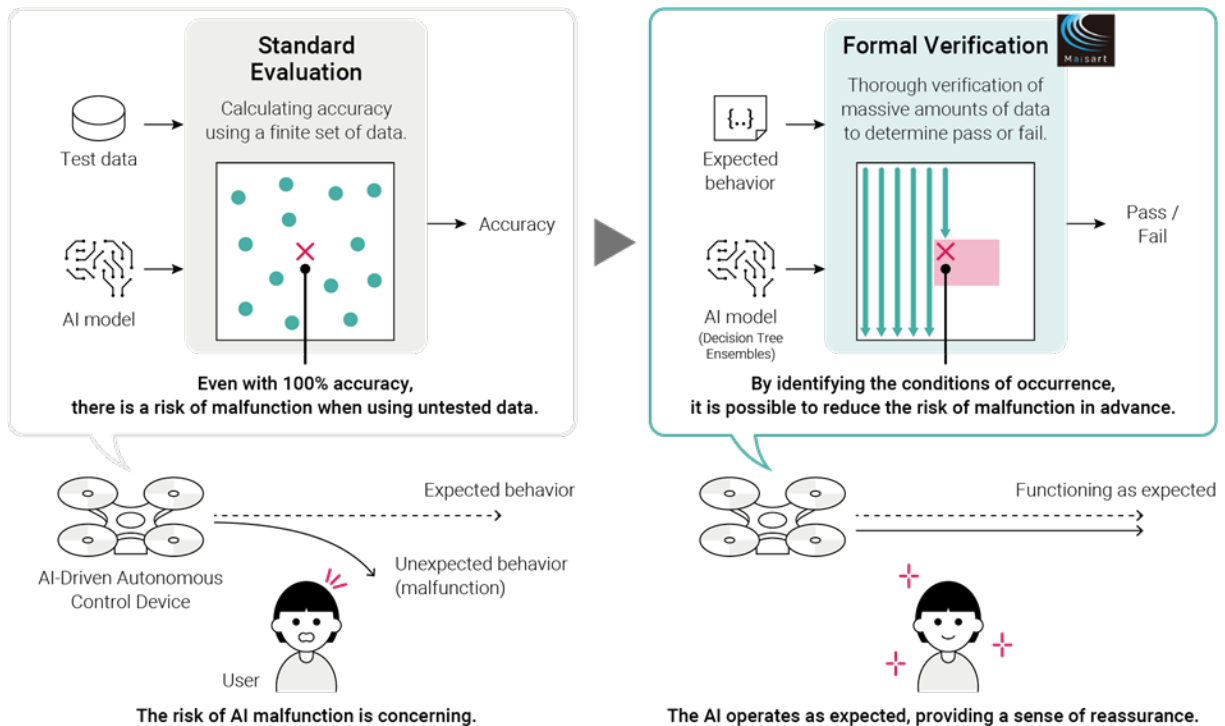
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## Mitsubishi Electric Develops Rapid Formal Verification Technology for AI

*Will help realize a society where AI can be used with greater confidence*



Comparison between standard AI performance evaluation and formal verification

**TOKYO, February 26, 2025** – [Mitsubishi Electric Corporation](https://www.mitsubishi-electric.com) (TOKYO: 6503) announced today that it has developed “rapid formal verification technology for AI,” targeting AI models known as decision tree ensembles.<sup>1</sup> This technology aims to reduce the risk of AI malfunctions and help realize a society where AI can be used with confidence. Its development is a direct consequence of the development of Mitsubishi Electric’s Maisart<sup>®</sup>.<sup>2</sup>

<sup>1</sup> A method that improves prediction accuracy by combining multiple decision trees, which are models that make predictions based on data partitioned according to specific conditions.

<sup>2</sup> Brand name (“Mitsubishi Electric’s AI creates the State-of-the-ART in Technology”) of AI for making devices smarter.

To address the rapid advance of AI technology and its increasing use globally, the world's first comprehensive legal framework for AI, the "EU Artificial Intelligence Act," came into effect on August 1, 2024. Countries around the world are establishing similar laws and guidelines to address AI risks, requiring businesses that develop and provide AI to manage these risks appropriately. The reliability of AI is particularly crucial in systems where safety is critical, such as autonomous control systems, power and social infrastructure systems, and cybersecurity systems, due to the significant damage that can be caused by errors.

Typically, AI reliability is evaluated using a finite set of test data not used in the model's training, assessing metrics such as accuracy. However, AI behavior is highly complex and even if the test results are 100% accurate, the risk of errors with untested data cannot be eliminated. To address this issue, a formal verification method has been proposed, which involves setting the expected behavior of AI in advance and rigorously verifying that it operates as expected without omissions. However, formal verification has been limited due to the enormous time required to verify large AI models and the difficulty in determining the priority of addressing the risk of malfunctions.

To address these issues, Mitsubishi Electric has developed a new algorithm aimed at efficiently conducting formal verification on decision tree ensembles, widely used for tasks like numerical data prediction, and an interactive verification tool utilizing this algorithm. By leveraging this technology, AI developers can rapidly cycle through formal verification processes, thereby reducing the risk of AI errors. This enhancement of AI reliability will help realize a society where AI can be used with greater confidence.

## **Features**

### ***1) Rapid risk assessment of AI errors through the deployment of an efficient formal verification algorithm***

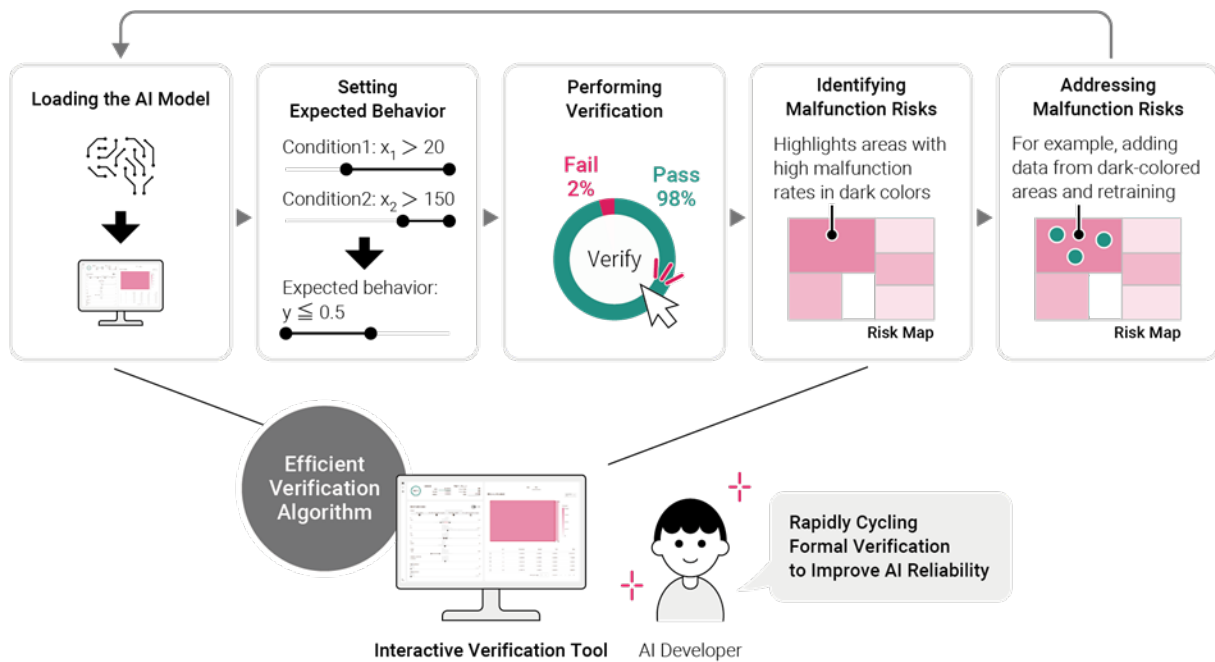
- An algorithm has been developed that enables efficient verification of decision tree ensembles. This allows for rigorous and thorough verification to ensure the AI operates as expected.
- It has been confirmed that the recursive partitioning of the input space of the AI achieves a verification process tens to hundreds of times faster than traditional formal verification methods.<sup>3</sup>

### ***2) Enables appropriate handling of the risk of errors with an intuitive interactive verification tool***

- The new tool allows users to perform formal verification intuitively through a browser-based graphical user interface (GUI). By loading a trained AI model and setting the expected behavior of the AI, verification can be executed with a single click.
- It displays verification results as a pass/fail ratio, enabling AI developers to understand the magnitude of the risk of malfunctions.
- It enables AI developers to appropriately address the risk of errors by visualizing the occurrence rates of these as a risk map with varying color intensities.

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<sup>3</sup> According to Mitsubishi Electric's research as of February 26, 2025.



The formal verification cycle

### **Future Development**

Mitsubishi Electric plans to conduct demonstrations targeting AI development both within the company and externally from the fiscal year 2026 onwards. Additionally, by collaborating with AI standardization activities and widely sharing the company’s development technologies, the company aims to help realize a society where AI can be used with confidence.

### **Reference**

For details of the efficient formal verification algorithm, please refer to the paper presented at the workshop of the International Conference on Data Mining (IEEE ICDM 2024)<sup>4</sup> and the Annual Conference of the Japanese Society for Artificial Intelligence (JSAI).<sup>5</sup>

*Maisart is a registered trademark of Mitsubishi Electric Corporation.*

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### **About Mitsubishi Electric Corporation**

With more than 100 years of experience in providing reliable, high-quality products, Mitsubishi Electric Corporation (TOKYO: 6503) is a recognized world leader in the manufacture, marketing and sales of electrical and electronic equipment used in information processing and communications, space development and satellite communications, consumer electronics, industrial technology, energy, transportation and building equipment. Mitsubishi Electric enriches society with technology in the spirit of its “Changes for the Better.” The company recorded a revenue of 5,257.9 billion yen (U.S.\$ 34.8 billion\*) in the fiscal year ended March 31, 2024. For more information, please visit [www.MitsubishiElectric.com](http://www.MitsubishiElectric.com)

\*U.S. dollar amounts are translated from yen at the rate of ¥151=U.S.\$1, the approximate rate on the Tokyo Foreign Exchange Market on March 31, 2024

<sup>4</sup> Saori Matsunaga, and Genta Yoshimura “Efficient and High-Quality Formal Verification for Decision Tree Ensembles” International Workshop on Adaptable, Reliable, and Responsible Learning (ARRL2024).

<sup>5</sup> Saori Matsunaga, and Genta Yoshimura “Formal Verification and Summarization of Results for Tree Ensemble Models” The 38<sup>th</sup> Annual Conference of the Japanese Society for Artificial Intelligence, 2024 (JSAI2024).