

# Cutting-edge technologies to realize “Digital Trust”



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chapter

1

# Digital Trust

# Rebuilding Trust for the New Normal Era

While “Trust” in conventional social systems is collapsing under the COVID-19 pandemic, the world expects us to build new systems to ensure trust in society based on a renewed sense of value and methods.



## Trust in Healthcare systems

- Development of drugs and treatment methods for a new infectious disease



## Business sustainability and growth

- Rebuilding supply chain and business model transformation for new lifestyles



## Trust in transaction

- Transparency of transaction, authenticity of transaction data, secure settlement methods



## Work style reform

- Promotion of non-face-to-face, safe and efficient work style, and business style change



## Appropriate balance between public health and privacy protection

- Behavior management of infected people and their close contact history while protecting their privacy

# Digital Trust: R&D Vision at Fujitsu Laboratories



- The means of securing trust is shifting into cyberspace
- We will play a leading role to ensure trust with our digital technology



Personal identification instead of seal

Explainability of AI

Laws / regulations

Contactless payment

AI quality management during operation

Protecting AI against malicious attacks

Rules for protecting personal information

Traceability of goods

Mutual connection of supply chain

System redundancy

Ethics

Code of conduct

Contract-based data transactions

Security by design

chapter

# 2 Technology strategy



## Computing

Fugaku, Digital Annealer, Quantum Computing, Content-Aware Computing



## Hybrid IT

Auto Bug Detection/Fix, Hybrid Ops/AI Ops, CI/CD, Auto-Adjust Container Parameters



## Data

Digital ID Tech., ConnectionChain Chain Data Lineage



## IoT

Dracena, Real-time Digital Twin, MEC/Hyperconverged Edge, Human Sensing



## 5G

Private 5G, Software Base Station, Millimeter-Wave Radio, Optical Transmission, Next-Generation 6G



## Cyber Security

Multimodal Biometric Authentication, AI for Security, Security for AI, Security by Design, Privacy Protection



## AI

Behavioral Analysis Tech., Explainable AI, Trusted AI, AI×HPC, Topological Data Analysis, High-Durability Learning



# DX

# AI

Innovative solutions to societal challenges using trustworthy analysis based on ethics and transparency

## Accountability of AI

Percentage of people who would trust AI if it showed substantial reasons for reaching its decisions

63%

Source: Fujitsu Technology and Service Vision 2019

### Explainable AI

Deep Tensor

+

Knowledge Graph

Explains the reasoning behind AI's decisions

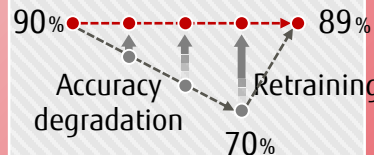
Reduced decision-making time for genomic medicine

14 days → 1 day

7

### High Durability Learning

Degradation monitoring and automatic repair of AI accuracy



Automatic repair reduces AI degradation over time

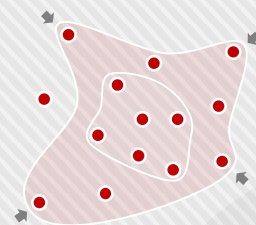
POC at a factory of a major beverage manufacturer

Automatic repair 98% ↑ 70%

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### Deep Twin

(Dimensional reduction and compression)



Detecting thyroid abnormalities (academic benchmark)

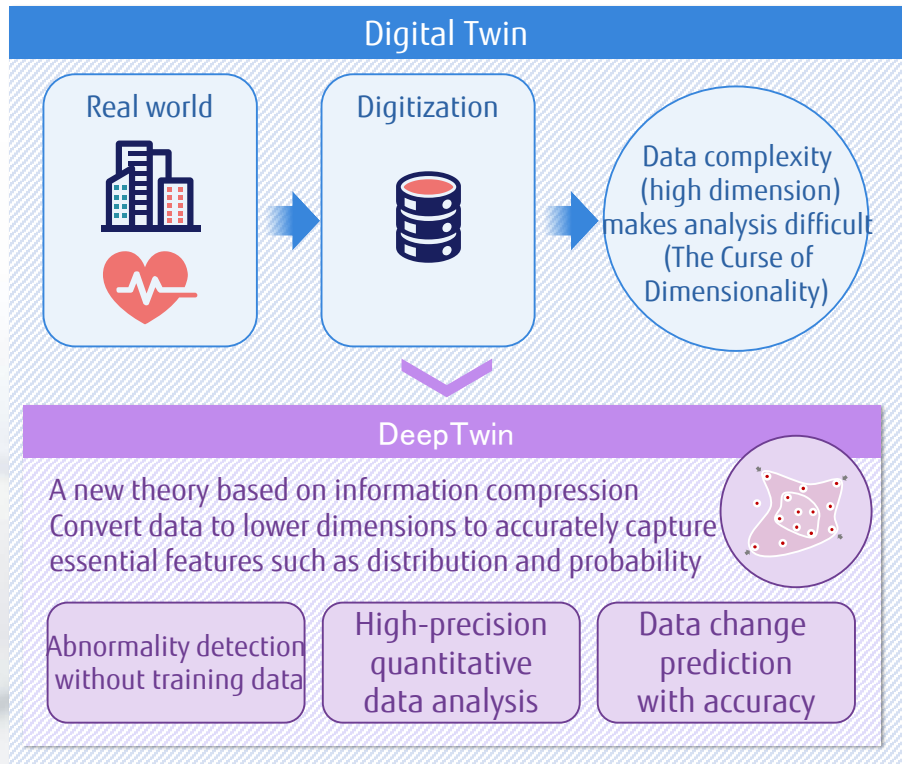
37% improvement

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# DeepTwin : Addressing the long-standing problem in AI

- More dimensions of data make learning difficult in practical time (The Curse of Dimensionality)
- We developed the new AI theory to solve this long-standing problem

2020/7/13 Press Release



**Big response**

Accepted by one of the most authoritative conference ICML

ICML: International Conference on Machine Learning

ICML | 2020  
Thirty-seventh International Conference on Machine Learning

Year (2020) -  
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Program Highlights >

Rate-distortion optimization guided autoencoder for isometric embedding in Euclidean latent space

Keizo Kato, Jing Zhou, Tomotake Sasaki, Akira Nakagawa

To analyze high-dimensional and complex data in the real world, deep generative models such as variational autoencoder (VAE) embed data in a reduced dimensional latent space and learn the probabilistic model in the latent space. However, they struggle to reproduce the probability distribution function (PDF) in the input space from that of the latent space accurately. If the embedding were isometric, this problem can be solved since PDFs in both spaces become proportional. To achieve isometric property, we propose Rate-Distortion Optimization guided autoencoder inspired by orthonormal transform coding. We show our method has the following properties: (i) the columns of the Jacobian matrix between two spaces is constantly-scaled orthonormal system and enable to embed

**Many in the media**

富士通、教師データなしでデータの特徴を正確に獲得できるAI技術 世界初

教師データなしでもAI技術の判断精度を向上

AIにおける「次元の呪い」解決へ、富士通が機械学習の最有力学会で発表

富士通研究所、教師データなしでデータの特徴を捉えるAI技術を開発

日本経済新聞

AIの課題「次元の呪い」解決 富士通が手法発表

**Invited Session at GTC, a Major International Conference**

A novel deep generative model for quantitative/transparent data analysis [A22541]

Benefit from deep neural network training on NVIDIA GPUs, current AI development has been boosted. Deep generative models are powerful scheme to capture the inherent feature from high-dimensional and complex data in the real world. Although many applications are developed based on this approach, the difficulty of the interpretation of the behavior of extracted features to the data has been an underlying issue. As a result, the probability distribution function (PDF) of the data cannot be estimated accurately. By utilizing information theory, especially rate distortion theory, we have found that a generative model can hold an inherent property that is the extracted feature preserve the quantitative trait of data such as PDF. Thanks to this property, we achieved state-of-the-art performance in unsupervised anomaly detection with four public datasets. We believe our method will further promote to develop transparent AI and a variety of applications.

Source: Nikkei / ZD Net Japan / Nikkei XTECH / EE Times / ITmedia / GTC NVIDIA



# Maintaining quality of AI: High Durability Learning **FUJITSU**

2019/10/25 Press Release

- It is inevitable that the accuracy of the learning model deteriorates in the actual operation of the AI system
- To solve the deterioration of accuracy, it is necessary to prepare learning data and retrain, but it's very costly

**Finance: Credit risk evaluation**



Accuracy deteriorates due to changes in economic structure, exchange rate, product price, interest rate, and regulations

Deterioration of accuracy (After a year) **91% → 69%**


**Retail: Classification of merchandise images**



Accuracy deteriorates due to changes in packaging after product design changes, campaigns, etc.

Deterioration of accuracy (After a year) **95% → 66%**

**Transportation: Delivery slip character recognition**



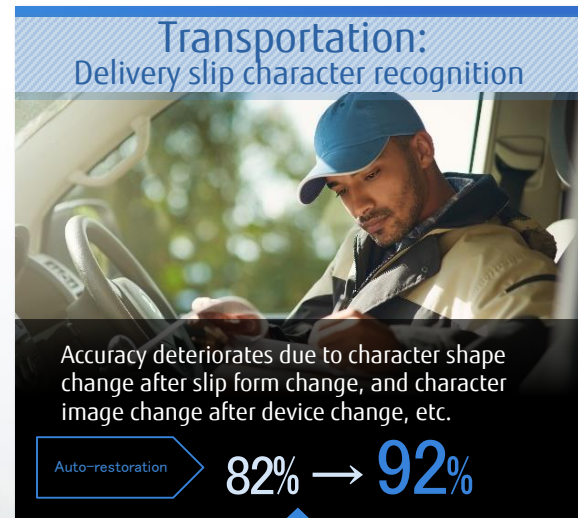
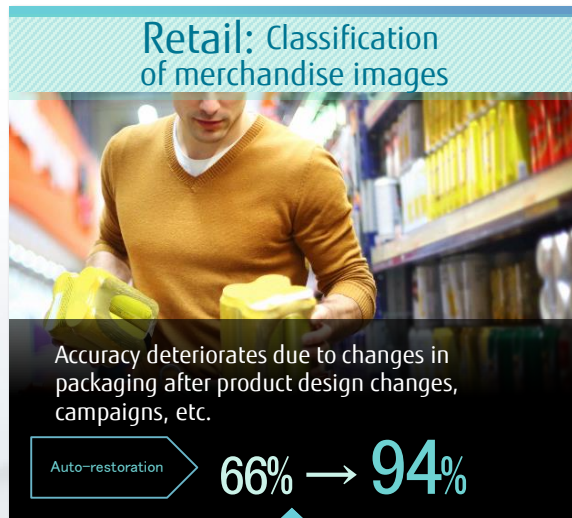
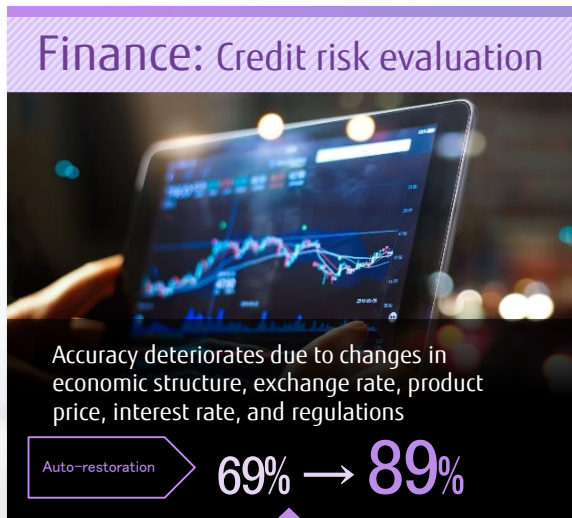
Accuracy deteriorates due to character shape change after slip form change, and character image change after device change, etc.

Deterioration of accuracy (After a year) **98% → 82%**

# Maintaining quality of AI: High Durability Learning

2019/10/25 Press Release

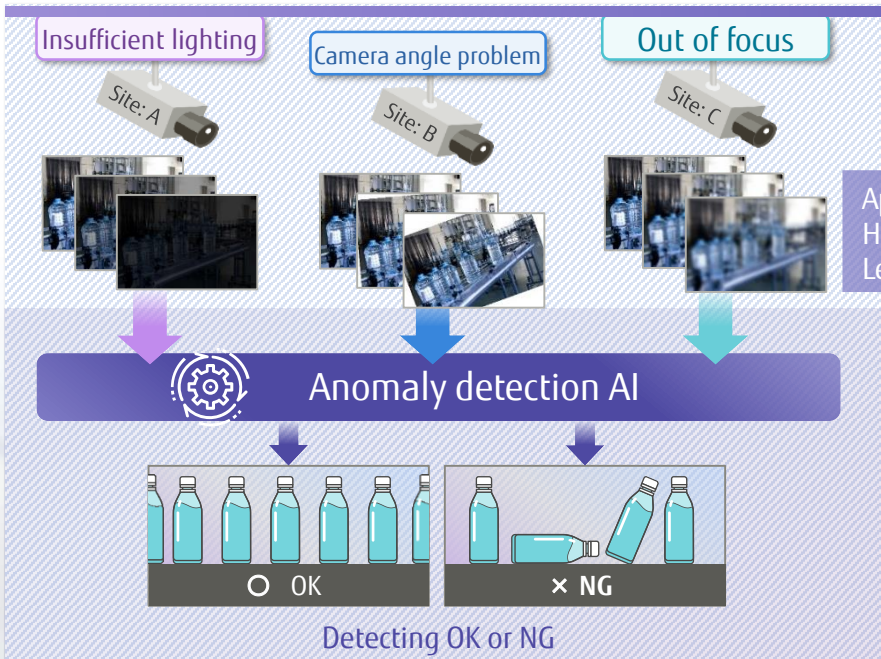
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Auto-restoration by High Durability Learning

# Application example: Anomaly detection manufacturing lines

- Applied to anomaly detection AI in the manufacturing line of a beverage production plant
- Realized the high-durability AI operation to cope with various kinds of data changes in work sites



## Anomaly detection AI in the manufacturing line

Application of High Durability Learning

- Camera position changes, Stains
- Difference of the number of lighting devices

① Prediction error	② Auto-restoration	③ Labeling workload
0.7%	70% → 98%	87% reduction

Accelerating toward practical application

# DATA

Risk management and value maximization of data utilization, including data authenticity and access rights

## Anxiety about the trustworthiness of information

Find it difficult to judge if online information is correct and trustworthy

70%

Source: Fujitsu Technology and Service Vision 2019

### ConnectionChain



Propose the project for Hyperledger with Accenture



Formally approved as "Hyperledger CACTUS"



### Digital ID Tech.



Create new services by linking various fields of ID information



Joint research in the Digital Identity field



Joint research with JCB

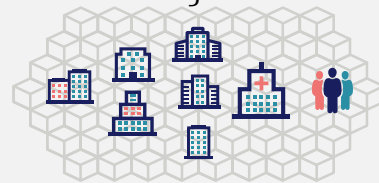
### Chain Data Lineage



Data history management and clearance for using personal information



Field trial to application to drug distribution management



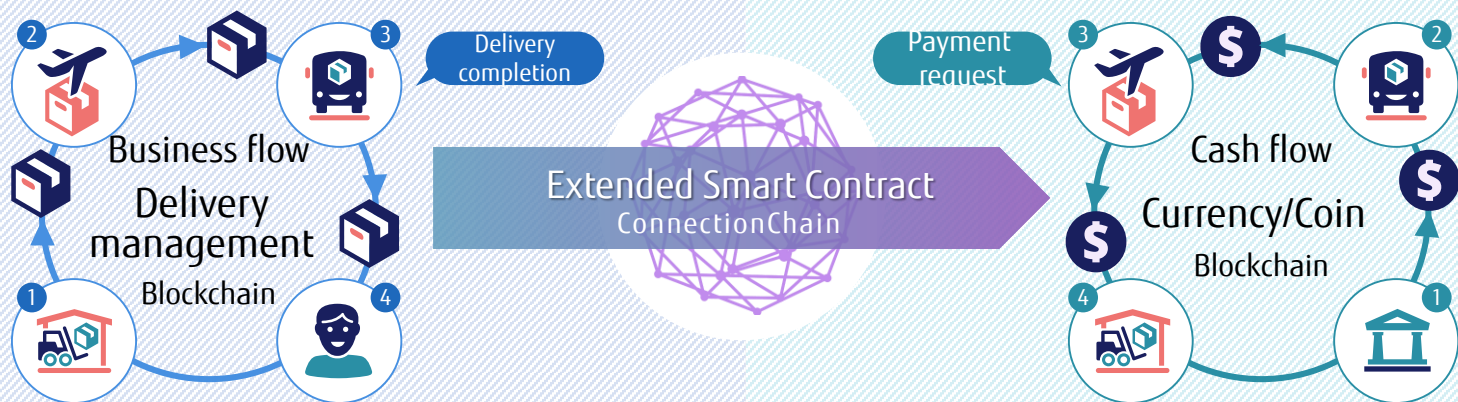
# ConnectionChain

2017/11/15 Press Release



## Blockchain connection technology essential for building distributed trust

- Abstraction technology to transparently and securely connect multiple blockchains which have different specifications
- Rollback technology to address failures that occur in new transactions across multiple blockchains



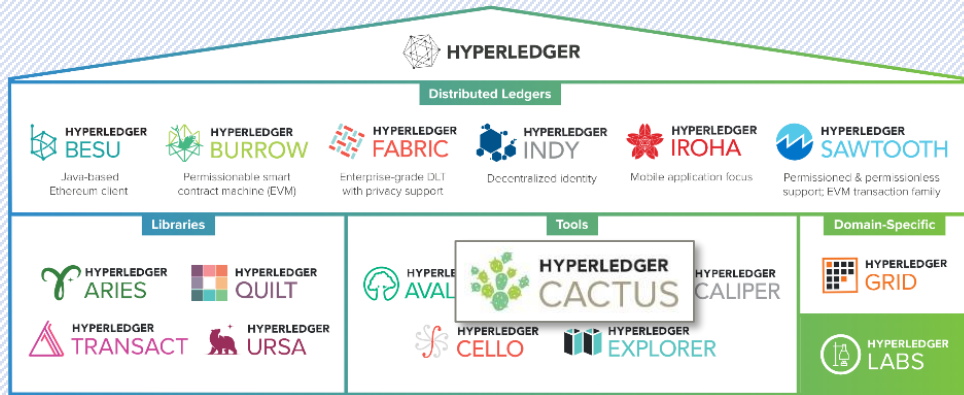
Field Trial of Decentralized Finance (DeFi) with BOOSTRY Co., Ltd. (May 2020)

# Dissemination of results by utilizing OSS

We lead the OSS community and aim for early realization of global standards

In the Hyperledger community, which is the largest consortium in enterprise blockchain, a project to interconnect blockchains named "Hyperledger Cactus" was started

2020/5/15 Press Release



We hope to standardize the plug-in function as OSS that facilitates the connection between various blockchains and contribute to the improvement of blockchain interoperability.

# Security

Realizing social safety and security from digital risks with zero-trust technology

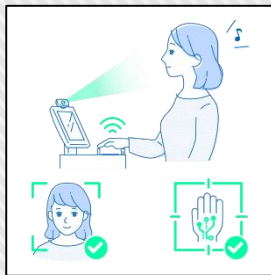
## Anxiety about security

68% are concerned about the risk of leakage of customer data and confidential information

68%

Source: Fujitsu Technology and Service Vision 2019

## Multi - biometrics authentication



Hygienic and privacy-friendly payment



Field trial of cash register free store with Lawson



15

## Trust as a Service (TaaS)



Digital trust mediation technology to ensure data authenticity across organizations

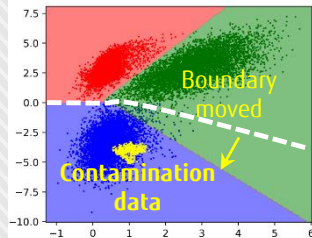


Rule making at Japan Digital Trust Forum



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## AI security



Detects deliberate changes in training data and protects against misjudgments



Developing Secure AI Methodology to protect AI

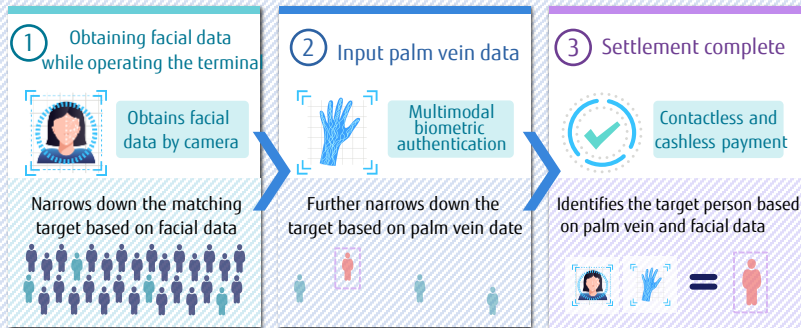


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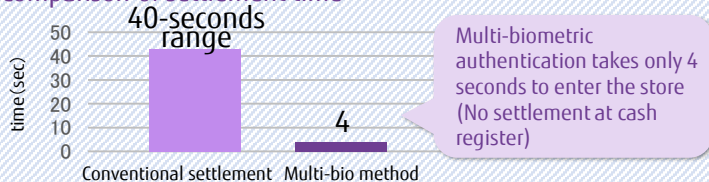
# Safe and convenient society realized by multi-biometric authentication without identity data at hand

- Combination of the authentication of palm vein and face can address up to 1 million people (actual store operation level)
- Interface controlled with the wave of a hand dramatically reduces payment time

Facial feature extraction technology for high-speed narrowing down and matching targets without omission



Comparison of settlement time





chapter

# 3 R&D Strategy on quantum computing

# Computing

Providing the increasingly complex and vast enormous computing capabilities needed to solve a range of societal challenges

Compared with the stagnation of Moore's Law (refinement), the improvement in AI compute is enormous\*

**300,000 x** Increase in 5 years

\* Source: "AI and Compute", OpenAI  
<https://openai.com/blog/ai-and-compute/>

## Innovation in Computing Technology ▶▶▶

**4 world records**

### Fugaku

Ranked No. 1 in the world for supercomputer performance

### Digital Annealer

Joint research in mid-molecular drug discovery (PeptiDream Inc.)

### Quantum Computing

Superconducting approach (RIKEN and University of Tokyo)

Optical approach (Delft University of Technology)

Quantum algorithms Error correction (Osaka University)

Press release on Oct 13

## Software Acceleration Technology ▶▶▶

### Content Aware Computing

Automated control of AI calculation accuracy



Software technology that maximizes computer performance

# Quantum computer

- A quantum computer is a computer that uses the principles of quantum mechanisms
- Based on the difference in operating principle, it is classified into the quantum gate-type and the ising machine-type

## Quantum gate-type

- Computation using "quantum gate" which is an arithmetic circuit combining quantum bits in which both zero and one exist simultaneously
- To perform general-purpose processing like a conventional computer
- There are many issues to be solved before practical application, such as error reduction, large scale, and high temperature operation

## Ising machine-type

- Method for searching solution by mapping problem to ferromagnetic model in statistical mechanics
- Specialize in combinatorial optimization problems
- Quantum annealing has a limitation on the problem that can be solved due to its difficulty on scale-up
- Quantum inspired method has an advantage in terms of practical application

# R&D strategy on quantum computing

## Quantum gate-type

- ▶ Started research and development as a general-purpose next-generation computing technology
- ▶ Work on everything from devices to application algorithms
- ▶ Open innovation with the world's leading research institutions

## Ising machine-type

- ▶ Digital Annealer commercial service launched in 2018
- ▶ Based on Digital Annealer 's world-class practicality, expanding business globally
- ▶ Expanding application areas through strategic partnerships

# Example : Toyota Systems

2020/9/10 Press Release



## Optimization of parts distribution network required for automobile manufacturing

- ✓ Explore more than **3 million routes** through hundreds of suppliers, several transit warehouses, dozens of factories
- ✓ Optimization of distribution costs, including the number of trucks, total mileage, sorting, etc.
- ✓ Demonstrated the possibility of reducing total distribution costs by **approx. 2 ~ 5%** by discovering effective distribution routes, improving loading efficiency, and increasing the number of trucks and the total distance traveled



Expecting  
Cost Reduction

**2~5%**

# New technologies announced today

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## Peptide drug discovery by DA

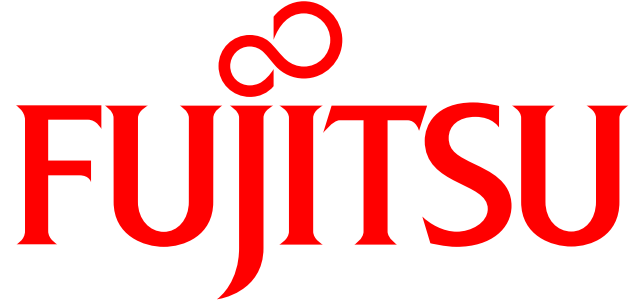
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Realizing highly accurate calculation of peptide drug discovery in cooperation with PeptiDream

## Quantum computing R&D strategy

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Initiated joint research  
with leading research institutions globally



shaping tomorrow with you