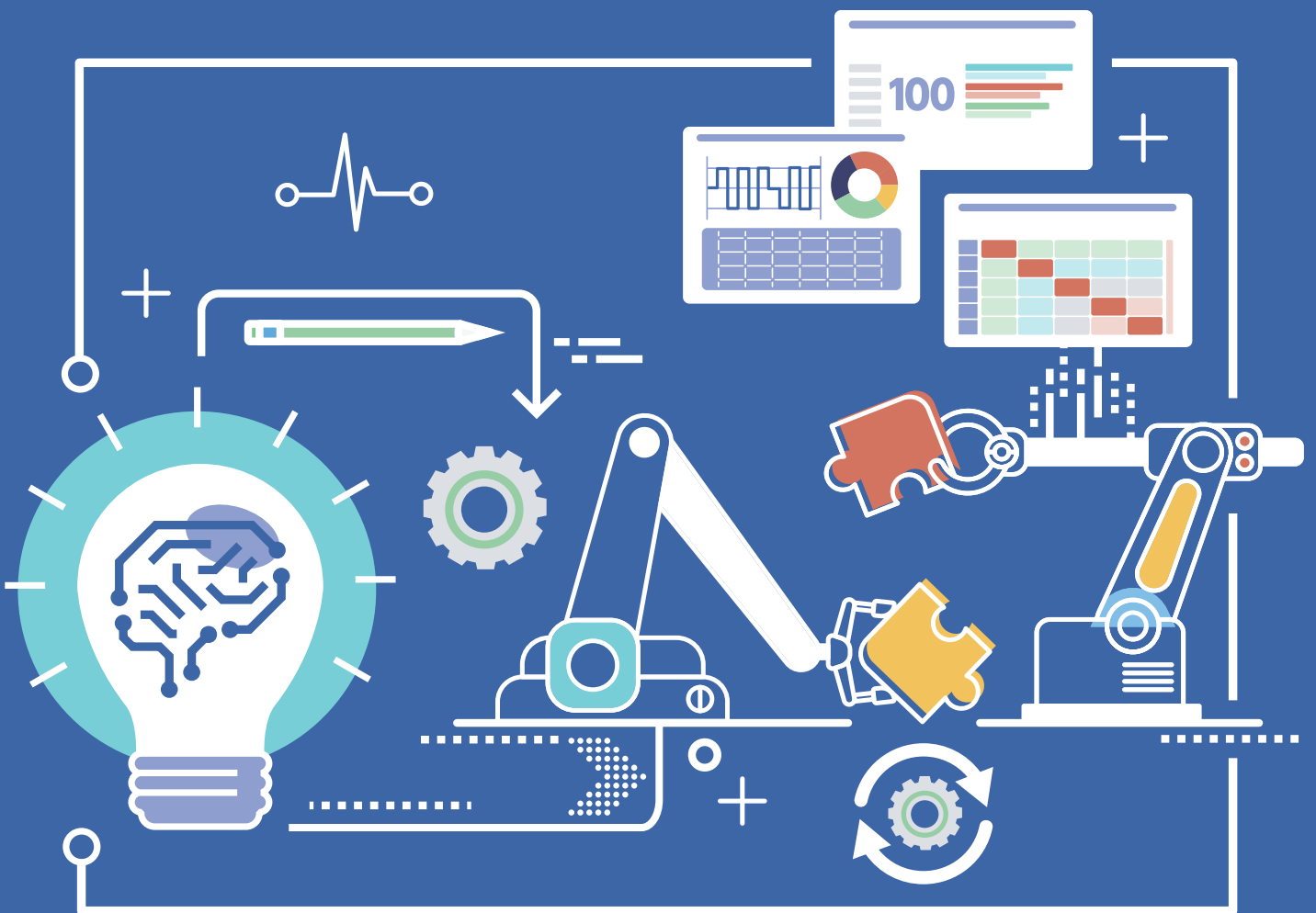**Mitsubishi Electric
Data Science Tool**

MELSOFT MaiLab

e-F@ctory

Maisart

GLOBAL IMPACT OF MITSUBISHI ELECTRIC

Through Mitsubishi Electric's vision, "Changes for the Better" are possible for a brighter future.

Changes for the Better

"Changes for the Better" represents the Mitsubishi Electric Group's attitude to "always strive to achieve something better", as we continue to change and grow. Each one of us shares a strong will and passion to continuously aim for change, reinforcing our commitment to creating "an even better tomorrow".

#41 2019 Forbes
TOP 100 DIGITAL COMPANIES

Our advances in AI and IoT are adding new value to society in diverse areas from automation to information systems. The creation of game-changing solutions is helping to transform the world, which is why we are honored to be recognized in the 2019 "Forbes Digital 100" as one of world's most influential digital corporations.

Mitsubishi Electric is involved in many areas including the following:

Energy and Electric Systems
A wide range of power and electrical products from generators to large-scale displays.

Electronic Devices
A wide portfolio of cutting-edge semiconductor devices for systems and products.

Home Appliance
Dependable consumer products like air conditioners and home entertainment systems.

Information and Communication Systems
Commercial and consumer-centric equipment, products and systems.

Industrial Automation Systems
Maximizing productivity and efficiency with cutting-edge automation technology.

Mitsubishi Electric Data Science Tool

MELSOFT MaiLab

INDEX

MELSOFT MaiLab

Although automation of equipment is advancing, there are still many processes that rely on the intuition and experience of on-site workers. By digitizing such knowledge, skill succession, dealing with labor shortages, cost reduction, improved productivity and quality, etc. can be achieved.

Challenge   **Still relying on the experience and intuition of skilled workers**

Cost reduction

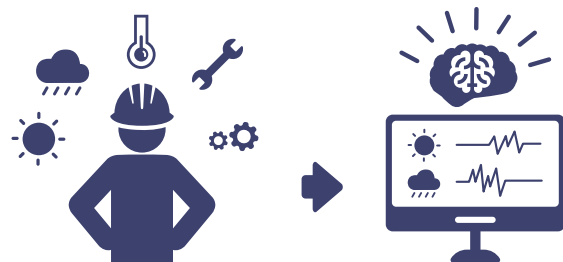Can we replace machine tools at the optimum timing by monitoring consumable condition?
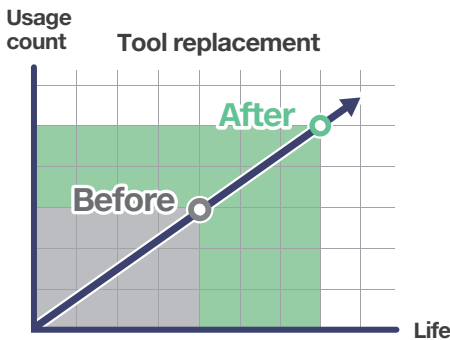
Skill succession and workforce saving

Can AI be used to pass on the knowhow of skilled workers to younger workers?

Improved productivity

Can we perform maintenance before sudden failures by monitoring equipment condition?

Improved quality

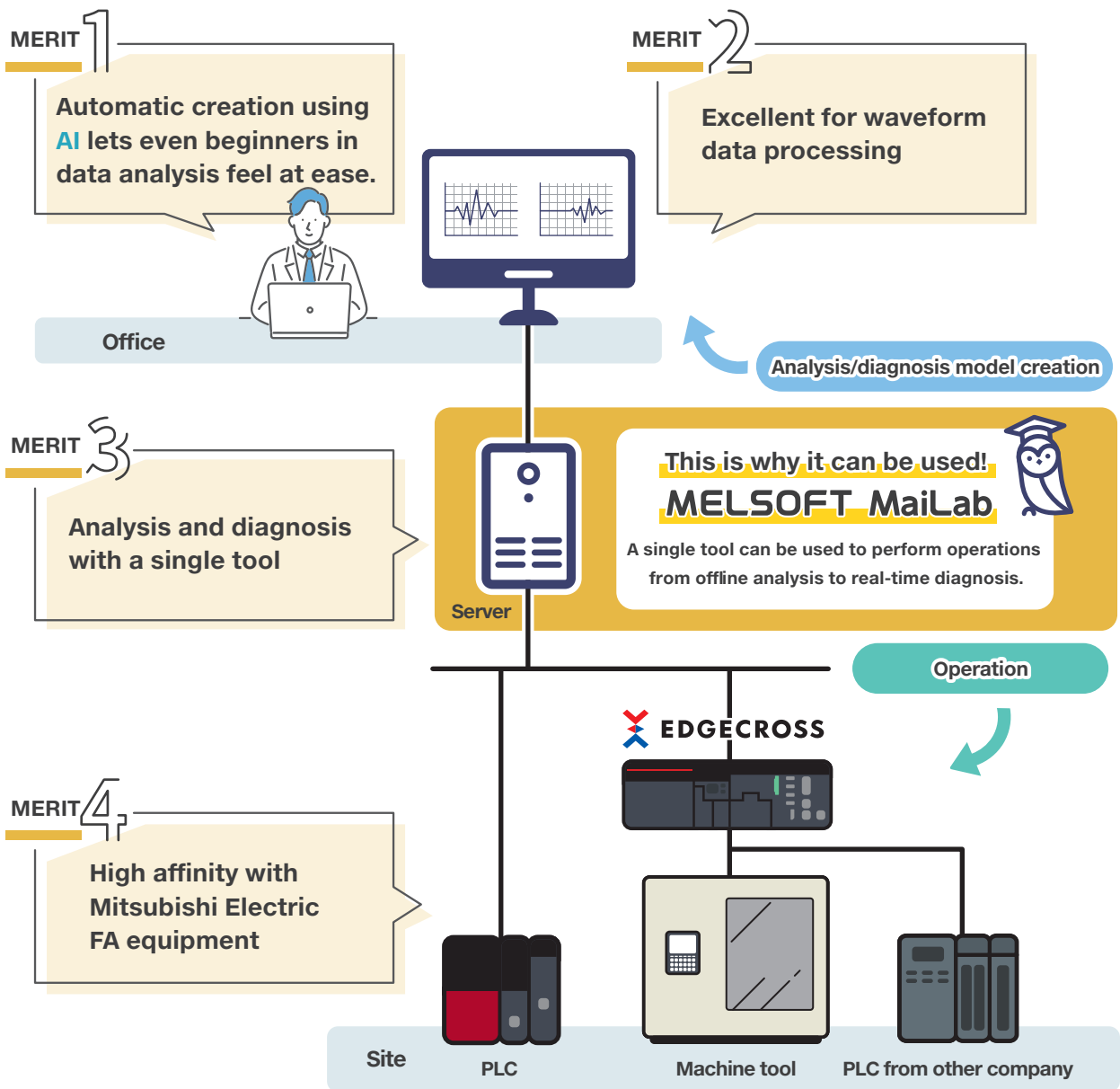Can manufacturing quality be verified without relying on operators?

MELSOFT MaiLab uses Mitsubishi Electric's Maisart* AI technology.

*Mitsubishi Electric's AI creates the State-of-the-ART in technology strategy.
 Mitsubishi Electric's AI technology brand that aims to make all devices smarter.

Mitsubishi Electric's Data Science Tool MELSOFT MaiLab is a data science tool that further improves manufacturing by replacing "human experience and intuition" with digital technology and enabling it to be easily incorporated into control systems.

Solution Replace human experience with digital technology. Utilize data.

MERIT 1
Automatic creation using **AI** lets even beginners in data analysis feel at ease.

Office

MERIT 2
Excellent for waveform data processing

Analysis/diagnosis model creation

MERIT 3
Analysis and diagnosis with a single tool

Server

This is why it can be used!
MELSOFT MaiLab
A single tool can be used to perform operations from offline analysis to real-time diagnosis.

Operation

EDGECROSS

MERIT 4
High affinity with Mitsubishi Electric FA equipment

Site   PLC   Machine tool   PLC from other company

Plus Mitsubishi Electric also offers services in which data analysis is performed by our data scientists on behalf of customers and services providing training in basic knowledge required for data analysis. (P19)
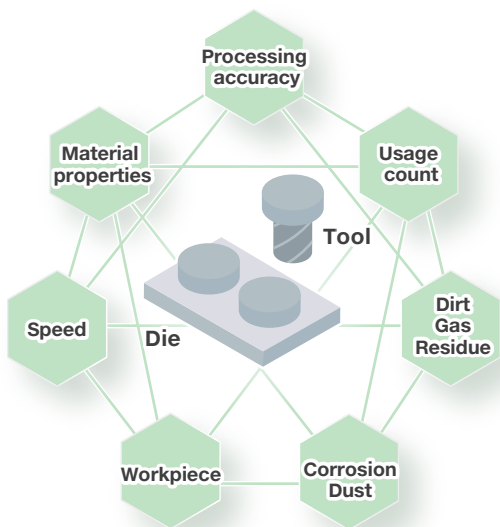
Diagnose tool life that can't be seen.

Diagnosing tool life from data to reduce costs

Challenge

Tool life that can't be seen
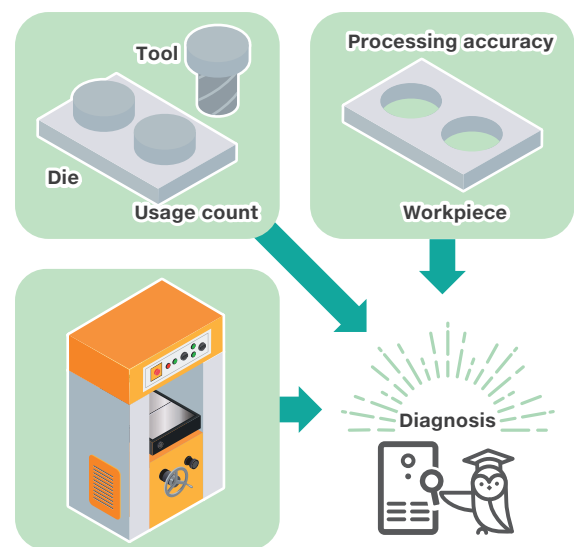
Dies required for metal processing and machine tools are extremely expensive and their lives are affected by various factors.

AI-based analysis

Find connections between diverse factors.

MELSOFT MaiLab uses AI to diagnose signs of abnormalities that are difficult for the human eye to detect.

Various parameters

Use fully up to the end of its life.
Improve equipment utilization ratio through optimum maintenance.

#Data utilization   #Life diagnosis   #Maintenance planning   #Cost reduction
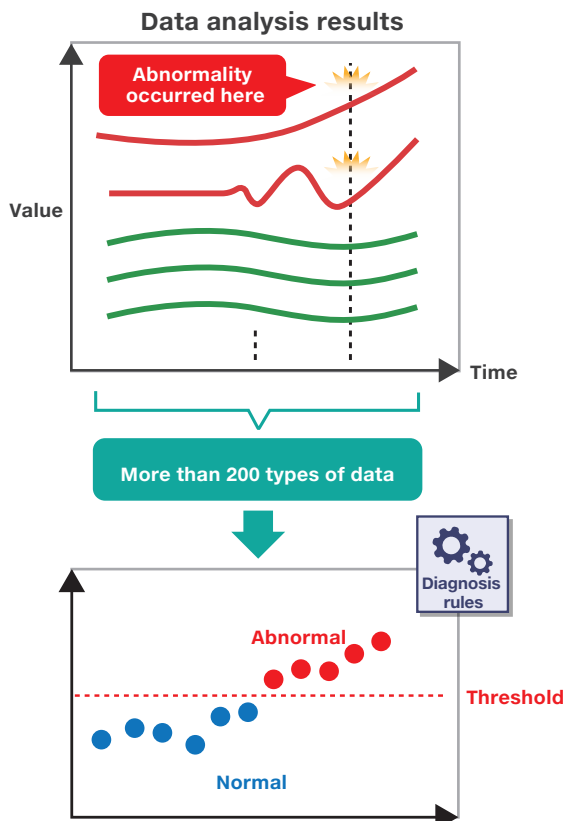
#Preventive maintenance   #Utilization ratio improvement   #Real-time diagnosis

AI-based solution

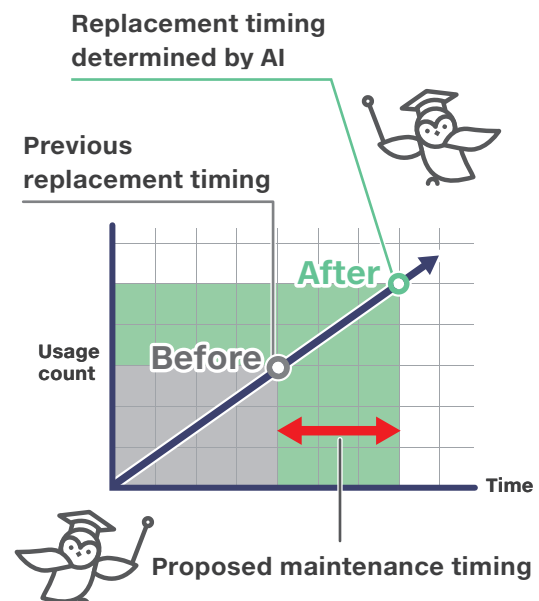### Finding optimum replacement timing

Monitors for signs of abnormalities to issue a warning of replacement or maintenance timing before failure occurs.

Cost reduction

Planned maintenance and reduced maintenance costs

Planned maintenance reduces the maintenance and operation costs of the entire factory and increases business competitiveness.

Data analysis results

Abnormality occurred here

Value

Time

More than 200 types of data

Diagnosis rules

Abnormal

Threshold

Normal

Replacement timing determined by AI

Previous replacement timing

After

Before

Usage count

Time

Proposed maintenance timing

Consistent quality on hot days and cold days

Passing on knowhow of skilled workers

··········· Challenge ···········

Still relying on the experience and intuition of skilled workers

In the food production industry, work has been done relying on the skills of skilled workers to maintain constant quality, but there are concerns about the future.
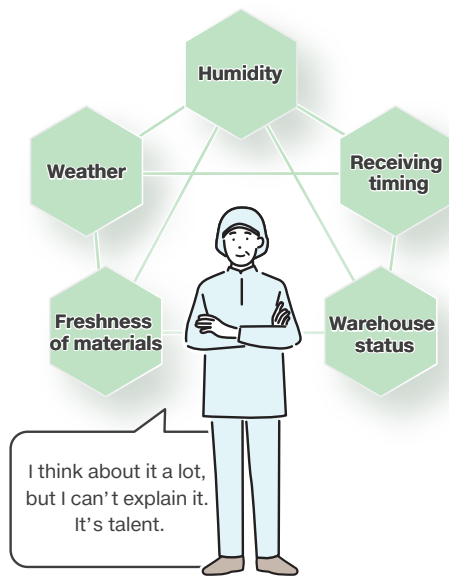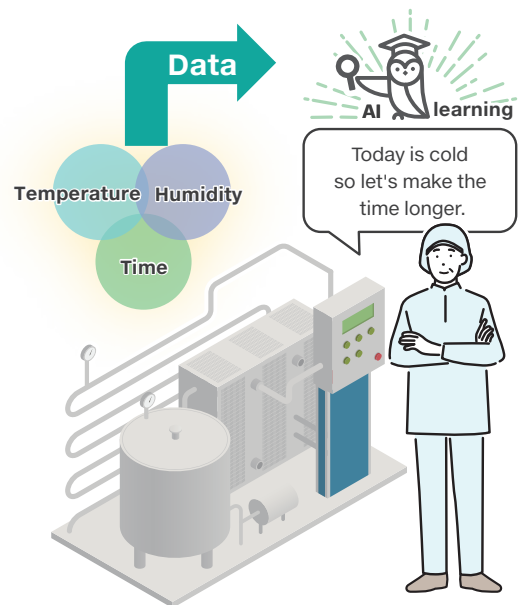
··········· AI learning ···········

Digitizing intuition and experience

By learning from a vast amount of data about the decisions made by skilled workers, MELSOFT MaiLab is now gradually absorbing the skills of skilled workers.

Humidity

Weather

Receiving timing

Freshness of materials

Warehouse status

I think about it a lot, but I can't explain it. It's talent.

Skilled worker

Data

AI learning

Temperature   Humidity

Time

Today is cold so let's make the time longer.

Mixer   Skilled worker

Digitizing the intuition and experience of skilled workers. Automation of equipment also deals with labor shortages.

#Data utilization #Digitalization #Site DX #Labor shortage #Quality improvement

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·········· **AI-based solution** ··········

Passing on knowhow of skilled workers

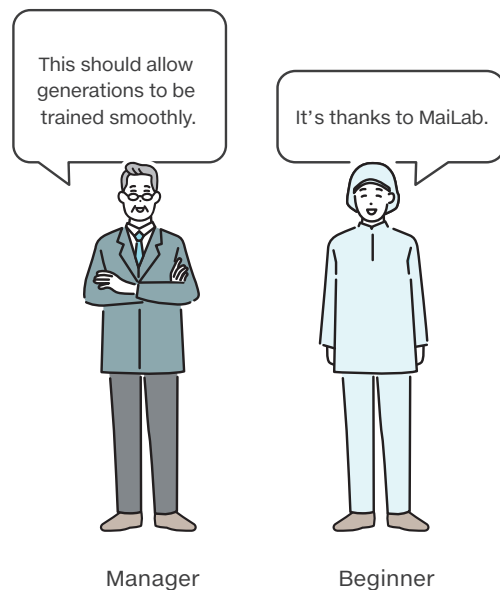MELSOFT MaiLab helps younger workers make the same decisions as skilled workers by using AI.

• Fermentation time and temperature control according to temperature and humidity
• Instructions on appropriate timing of addition of materials
• Inventory control according to shipment status
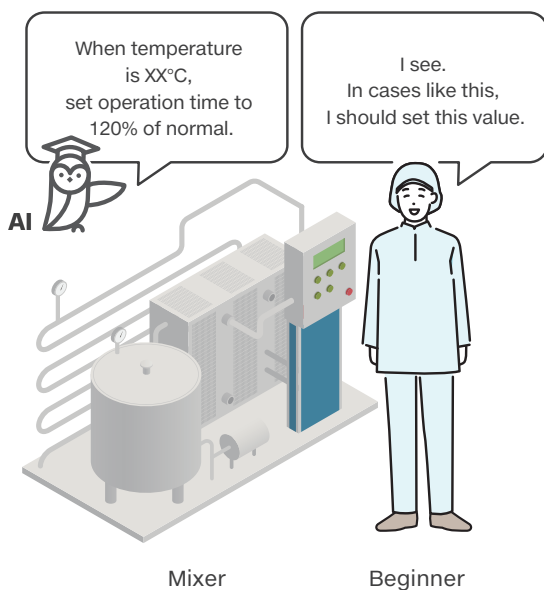
Human resources development

Your teacher, MELSOFT MaiLab

With a help of AI, beginners will gradually learn how to combine data that skilled workers have been doing, and someday they may surpass the skilled workers.

When temperature is XX°C, set operation time to 120% of normal.

I see. In cases like this, I should set this value.

AI

This should allow generations to be trained smoothly.

It's thanks to MaiLab.

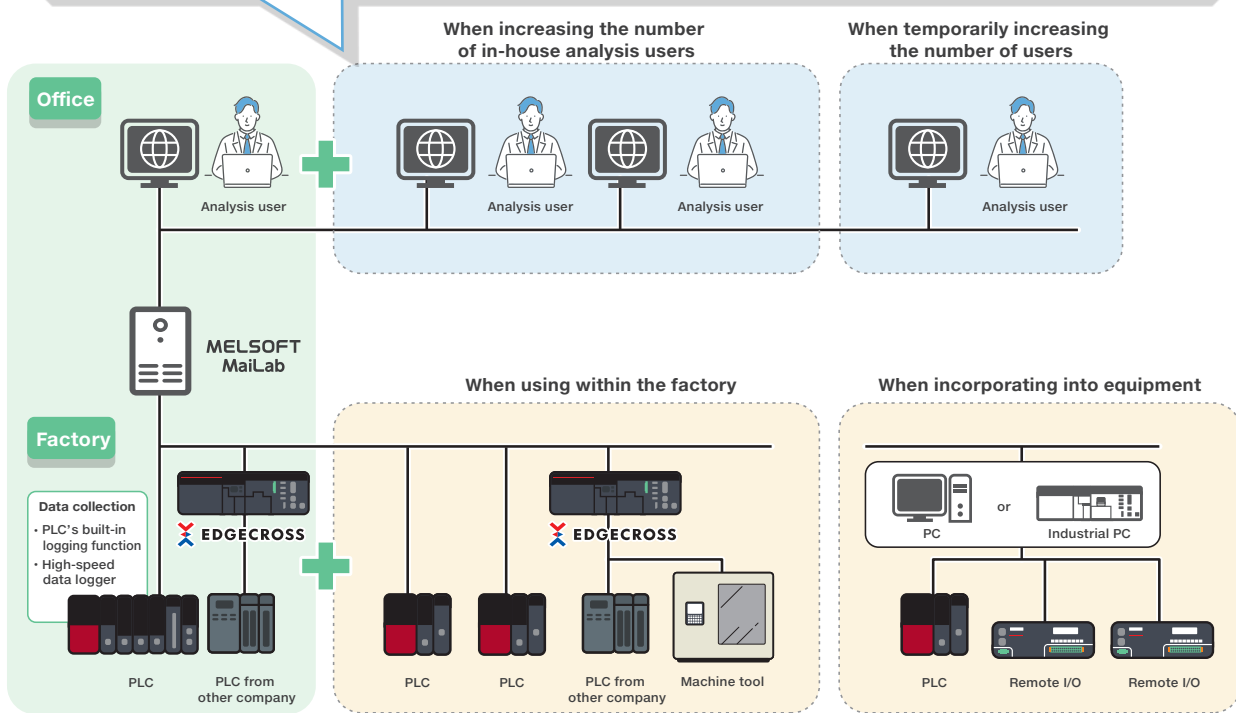Mixer   Beginner   Manager   Beginner

License format according to scale

Data collection and diagnosis can be started in MELSOFT MaiLab with just a basic license. In addition, systems can be freely configured according to the scale of facilities, increases in the number of analysis users, etc.

Additional user license — Annual renewal

Flexibly respond to increases or decreases in the number of analysis users.

You can add analysis users.
Licenses for the analysis users that you want to add can be granted by linking them to the basic license. Even temporary increases in personnel can be flexibly handled.

When increasing the number of in-house analysis users

When temporarily increasing the number of users

Office

Analysis user

Analysis user   Analysis user

Analysis user

MELSOFT MaiLab

Factory

When using within the factory

When incorporating into equipment

Data collection
· PLC's built-in logging function
· High-speed data logger

EDGECROSS

EDGECROSS

PC   or   Industrial PC

PLC   PLC from other company

PLC   PLC   PLC from other company   Machine tool

PLC   Remote I/O   Remote I/O

Additional diagnosis licenses — One-time purchase

For factory expansion or incorporation into mass-production products.

Equipment and facilities subject to diagnosis can be expanded.
There are no renewal costs when adding equipment within the factory, or when incorporating data diagnosis systems into mass-production equipment.

License

\ Annual renewal /
Basic license

\ Annual renewal /
Additional user license

\ One-time purchase /
Additional diagnosis licenses

Learning operating environment

In the minimum operating environment, it is possible to execute methods such as multiple regression analysis, etc. with relatively low calculation processing when no other tools are running. To execute methods such as deep learning, etc. that require lots of calculation processing, the recommended operating environment is necessary.

Item	Description	
	Minimum	Recommended
Computer	PC, industrial PC, server	
CPU	Intel® Core™-i3 equivalent or better	Intel® Core™-i7 equivalent or better[1]
Memory	4 GB or more	16 GB or more[1]
OS	English, Simplified Chinese, Japanese versions	
	64-bit	
	Windows® 10 (Pro, Enterprise, IoT Enterprise) Windows Server 2019 (Datacenter, Standard, Essentials) Windows Server 2016 (Datacenter, Standard, Essentials)	
Available storage space	16 GB or more	64 GB or more

Collection/diagnosis operating environment

Item	Description	
	Minimum	Recommended
Computer	PC, industrial PC, server	
CPU	Intel® Core™-i3 equivalent or better	Intel® Core™-i7 equivalent or better[1]
Memory	4 GB or more	8 GB or more[1]
OS	English, Simplified Chinese, Japanese versions	
	64-bit	
	Windows® 10 (Pro, Enterprise, IoT Enterprise) Windows Server 2019 (Datacenter, Standard, Essentials) Windows Server 2016 (Datacenter, Standard, Essentials)	
Available storage space	16 GB or more	32 GB or more[1]

[1] Required when executing not just methods such as multiple regression analysis, etc. with relatively low calculation processing, but methods such as deep learning, etc. that require lots of calculation processing.

Easy analysis/diagnosis in 4 steps

MELSOFT MaiLab is a tool that enables easy data analysis in 4 basic steps.

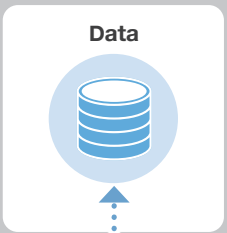First, data visualization.
Graph displays for easy
understanding.
…P14

AI for automatic support.
Automatic AI creation from
what you want to do.
…P16

| Data collection	Offline analysis	

Data collection

Examine what data should be collected and how they should be collected.

STEP 01 Data set creation

First, read the data to be analyzed into MELSOFT MaiLab and register them. A group of registered data is called a "data set".
The data set can be shown in various kinds of graphs, so that it can also be easily checked by human eyes before performing diagnosis using AI.
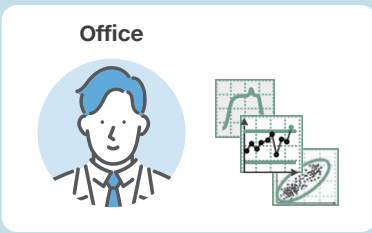
STEP 02 AI creation

Learning from the data set is performed.
A model that enables diagnosis of unknown data is called "AI".
When "What you want to do (objective)" is selected, the regularity and rules of the data are automatically derived, and MELSOFT MaiLab creates the "AI".

Data

Office

99
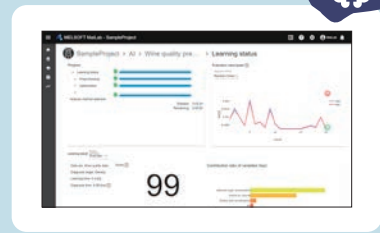
Data accumulation

Production site

and more

To further increase accuracy, customizable data analysis is also available.
...P19

Create tasks from learning. Scores and contribution rate make accuracy also clear at a glance.
...P17

Linking with site is also easy. Apply to equipment with a single click.
...P20

Real-time diagnosis

STEP 03 — Task creation

Settings for performing diagnosis of unknown data are called a "task".
MELSOFT MaiLab will define the data input/output methods and threshold values for whether diagnostic results are good or bad. The accuracy is displayed as a score, which serves as a guideline for judgment.

Diagnosis rules

STEP 04 — Task execution and monitoring

You can execute tasks and monitor the diagnosis status of unknown data. Deployment to equipment can be easily performed with just a click. Data flow and good or bad judgment status can be confirmed on a graphical display via the learning server.
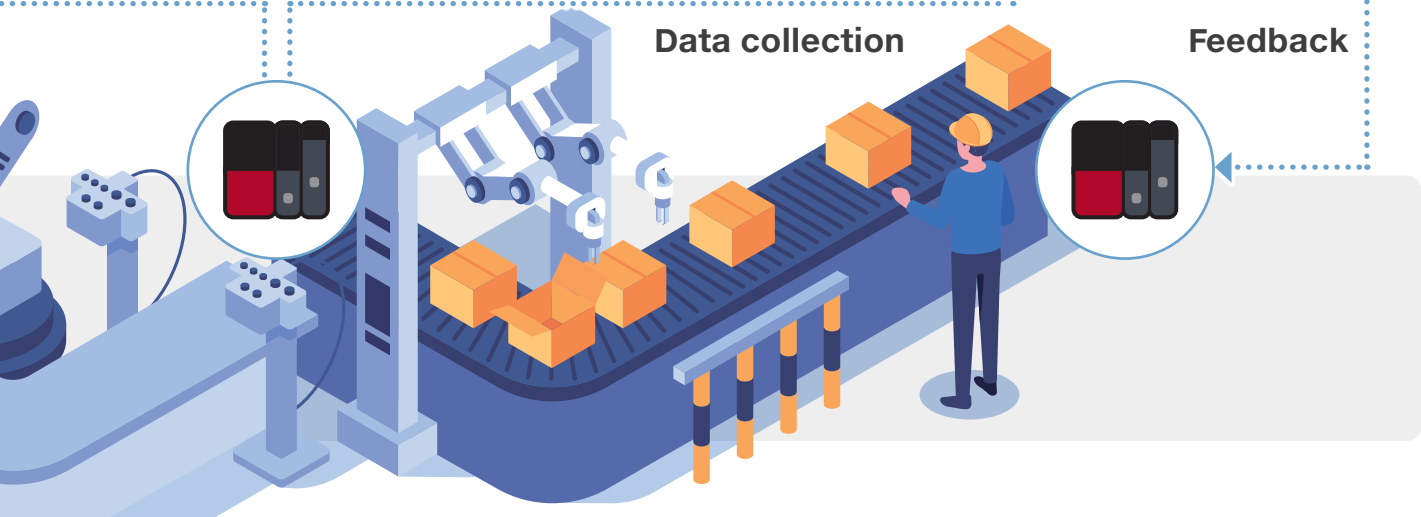
Office

Data collection

Feedback

Easy data registration and visual confirmation

First, look at the data. It's also effective for analysis performed by hand.

Prepare the data. (Data set creation)

In order to analyze the data and create the diagnosis model, it is necessary to register the data subject to analysis in MELSOFT MaiLab. A group of registered data is called a "data set". By registering the data set, the data can be visualized in tables or graphs, and diagnosis models can be created.
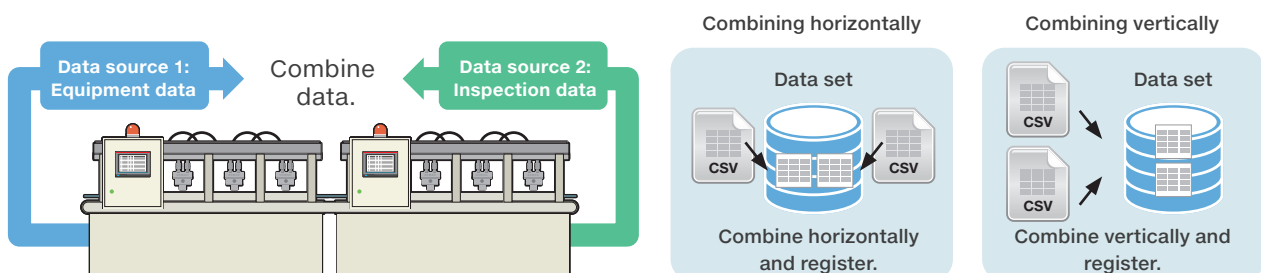

Data source (CSV/TSV) → Registration → Data set → Visualization → Displayed graphs
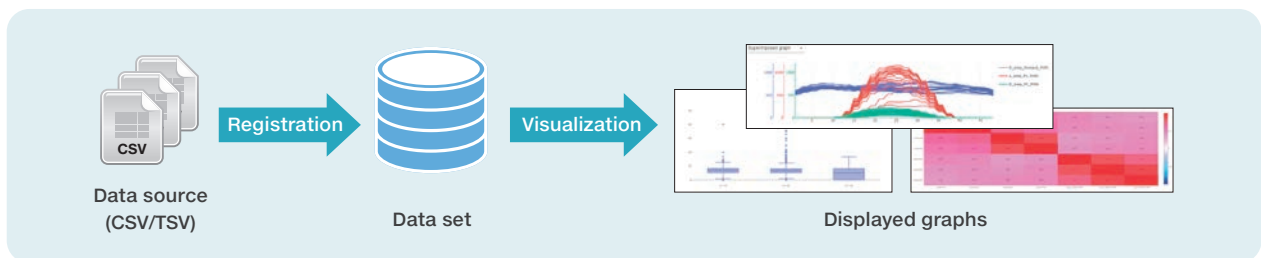
▌Data registration can be performed by simple mouse operations.

The original file of data to be registered as a data set is called the "data source". Data sources which can be registered are CSV-format and TSV-format text files.

Uploaded data can be easily visualized.

Drag and drop the CSV-format data source.

Data source (CSV/TSV)

▌Link data that seem related.

When the data sources are multiple files, data sources can be combined with each other and registered as a single data set. This is used in cases such as connecting both "equipment data" measured by sensors at the time of manufacture and "inspection data" recorded from inspections after manufacturing, and performing learning.

Data source 1: Equipment data → Combine data. ← Data source 2: Inspection data

Combining horizontally

Data set

Combine horizontally and register.

Combining vertically

Data set

Combine vertically and register.

▌ Look at the registered data in various forms.

Registered data can be verified while switching between display formats.
Since you can switch between graphs displaying data by just selecting the data set and display format, you can notice data characteristics that you had not noticed before.
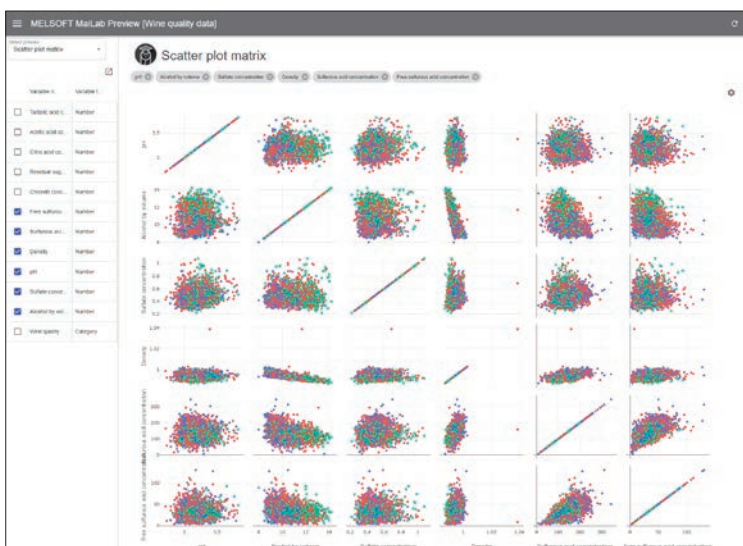

Line graph and histogram

Pie chart and histogram

Correlation matrix heat graph

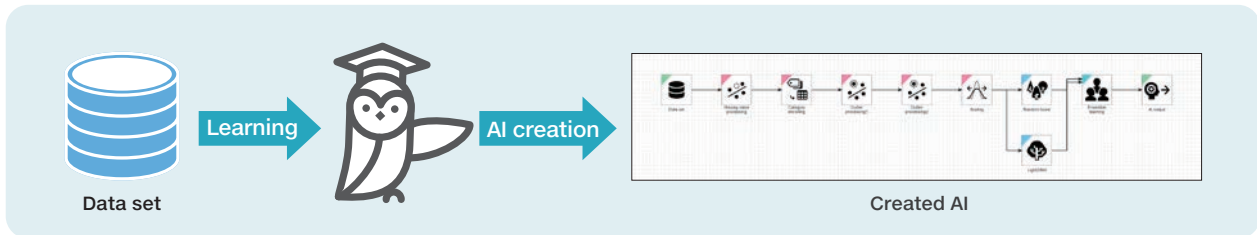Scatter plot matrix

Automatic learning based on your objectives

You can create the optimum diagnosis.
You can begin analysis even without specialized AI knowledge.

Create diagnosis rules. (AI creation)

Perform pre-processing of the data set and create AI by performing learning according to analysis methods.

Data set → Learning → AI creation → Created AI

▌Interactive and easy. Automatic AI creation saves time and effort.

Automatic

MELSOFT MaiLab selects the optimum pre-processing and analysis methods based on the objectives and data set contents, and automatically creates the AI. Select this when you don't know what analysis method to use for what you want to do (objectives).

Manual

In this method, you select the analysis methods yourself and create the AI.
Select this when the appropriate method for what you want to do (objectives) is clear.


▌Then leave it to the system. Wait for the learning results.

When setting of objectives and methods has been completed, the system proceeds to learning.
The status of AI-base learning is displayed.

When learning has been completed, the AI is created and the learning results (scores) and contribution rates of variables are displayed.

■ Are you worried about AI accuracy? You can judge the learning results.
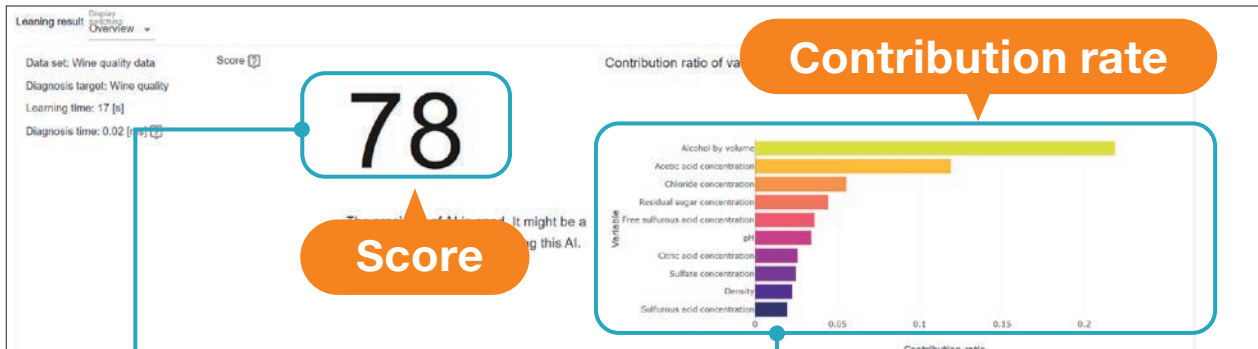
Learning results (scores)

Learning results are displayed from 0 to 100 points.
Since you can use the scores to judge how well the model was made, you can evaluate the reliability of the diagnosis model even without specialized knowledge.

*When the scores are low, you can review the learning level and judge whether to perform re-learning, etc.

Contribution rates of variables

A numerical value indicating the degree of influence of each explanatory variable (variable that causes something) relative to the predicted results. Since the explanatory variables with the top 10 contribution rates are shown, you can easily understand the correlations between data even without performing data analysis yourself.

*The displayed explanatory variables also include some automatically created by MELSOFT MaiLab.

■ Complete the AI.

Proceed to creating the task to perform real-time diagnosis while referring to the displayed scores and comments, When learning has been completed, AI creation will be completed.
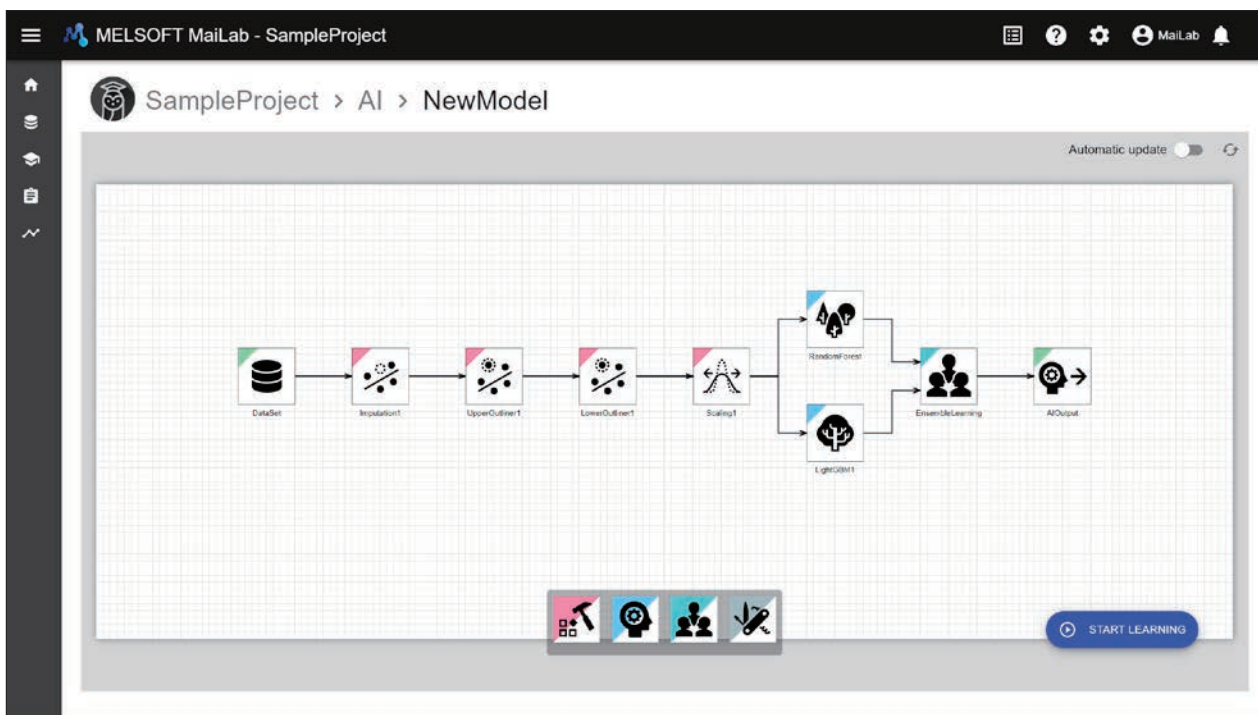
You can manually change the completed AI to customize it to increase reliability.

Customizable AI

You can also freely create AI models with higher accuracy.

MELSOFT MaiLab not only automatically creates AI, it also lets you customize the created AI or create your own original AI.
You can construct AI models with higher accuracy.

▌You can customize the AI to increase its accuracy.

In MELSOFT MaiLab, each process of AI is performed in a block, and the AI processing flow is created by connecting the blocks. You can edit the AI flow prepared by the AutoML function to freely customize it or create an original AI from scratch.
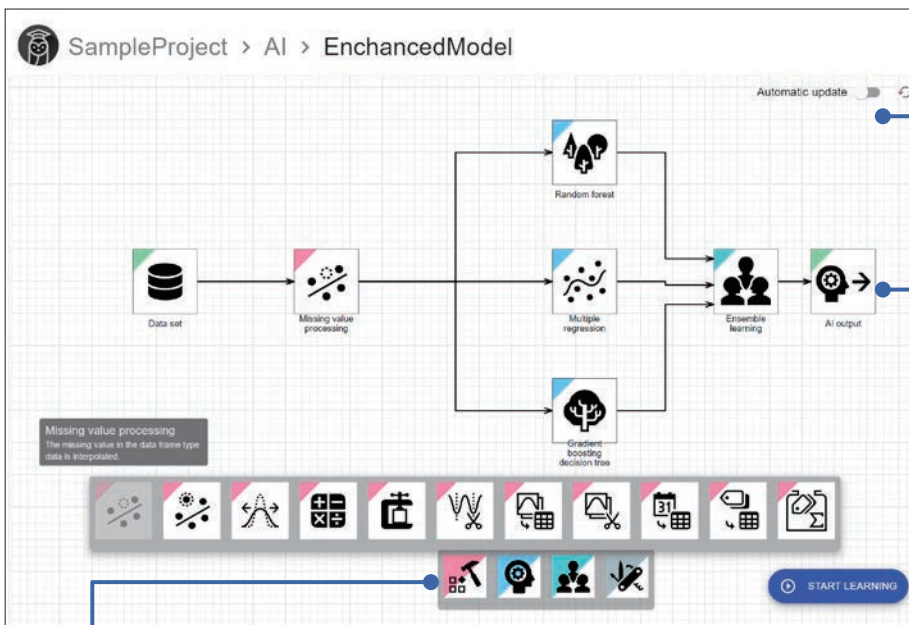
Canvas
The place where blocks and connectors are arranged. It is shown like graph paper.

You can freely create AI by connecting the output and input of blocks on the canvas.

Function expansion blocks are also available for executing desired processing in AI. The types of blocks will be introduced.
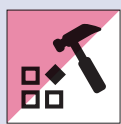
Pre-processing category
Includes blocks that do pre-processing of input data in order to increase the accuracy of analysis performed downstream.

Ensemble learning category
Includes ensemble learning blocks that combine multiple analysis methods and output a single diagnosis rule.

Analysis methods category
Includes blocks that execute each type of analysis method algorithm and output diagnosis rules on input data.
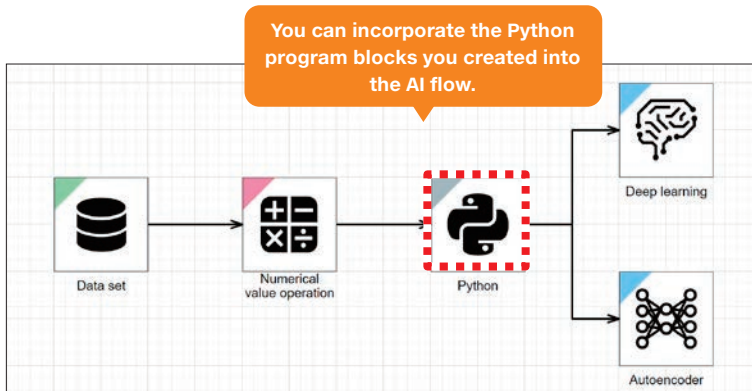
Utility category
Includes blocks that can be placed at various places in the processing flow for various purposes such as changing processing content or input/output, etc.

▌Original processing can be performed with Python blocks.

MELSOFT MaiLab is also equipped with function expansion blocks that are useful for customizing learning models. You can also perform coding in Python, which is often used in data analysis. By performing customization, you can create learning models with higher accuracy.

> You can incorporate the Python program blocks you created into the AI flow.

Data set → Numerical value operation → Python → Deep learning / Autoencoder

For example, when the product lot number includes product type information or when values calculated from sensor data using certain equations are used in manufacturing, etc., that information can be used as new characteristic values.

> Python code is shown directly in the editor.

> Execution results are shown on the same screen for easy debugging.

If you want even more customization:

Data analysis support service   Data analysis training

Mitsubishi Electric offers 2 support services for customers to create their own AI.

Data analysis support service	• Service flow	• Image of analysis report
Our data scientists perform data analysis on behalf of customers.	Interviews → Estimate → Data analysis support service → Analysis results report • Data understanding • Data processing • Data analysis Analysis report	

Data analysis training	• Hands-on training	• Textbook filled with analysis knowhow
Training is performed on basic concepts and knowledge for implementing data analysis.		

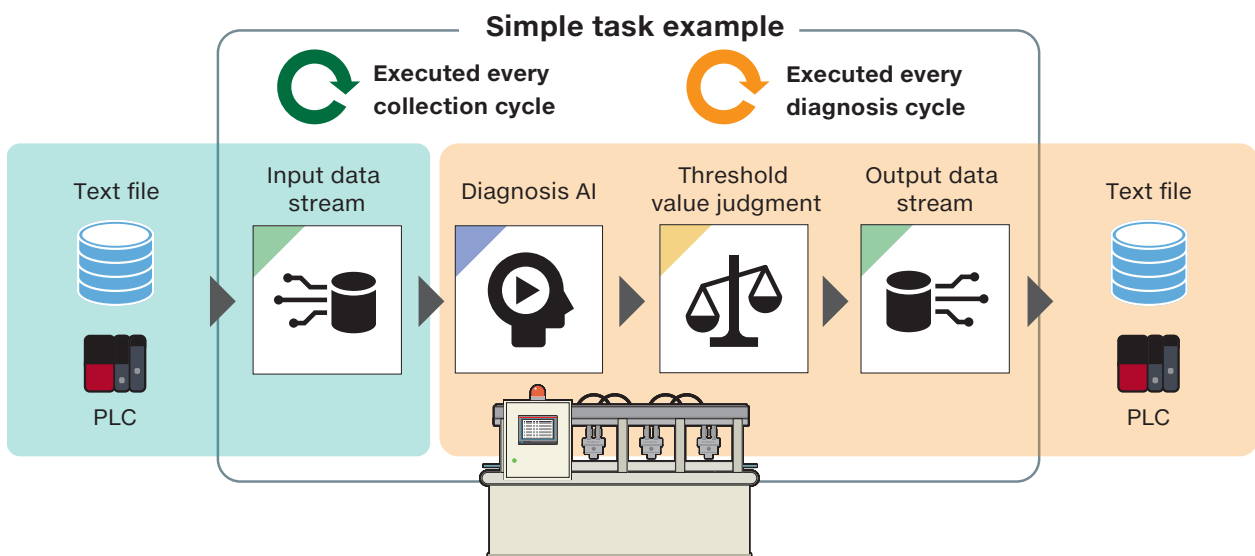# Easy to apply the results to equipment

Link to the site with one button and start real-time diagnosis.

Implementing in the device (task creation)

A group of processes (process flow) using the created AI to perform diagnosis on unknown input data and output the diagnosis results is called a "task" in MELSOFT MaiLab.*
A simple task can be automatically created by setting the necessary parameters for the operation of each process.

Simple task example

Executed every collection cycle

Executed every diagnosis cycle

| Text file | Input data stream | Diagnosis AI | Threshold value judgment | Output data stream | Text file |

PLC

PLC

*There are 2 types of tasks: simple and advanced. For details, please refer to the manuals.

▌ When using Mitsubishi Electric FA equipment, devices can be specified directly.

MELSOFT MaiLab has high affinity with Mitsubishi Electric FA equipment.
Since direct specification of compatible devices can be performed, device deployment (arrangement) can also be performed easily.

Select "Mitsubishi Electric FA Connector."

Select a CPU type.

Select the communication I/F.

MELSOFT MaiLab enables performing up to deployment to the site with a single tool.

From input data stream settings, select "Mitsubishi Electric FA Connector" for the connection method.

The status is shown in real time during task execution.

Diagnosis results are shown in line graphs and pie charts.
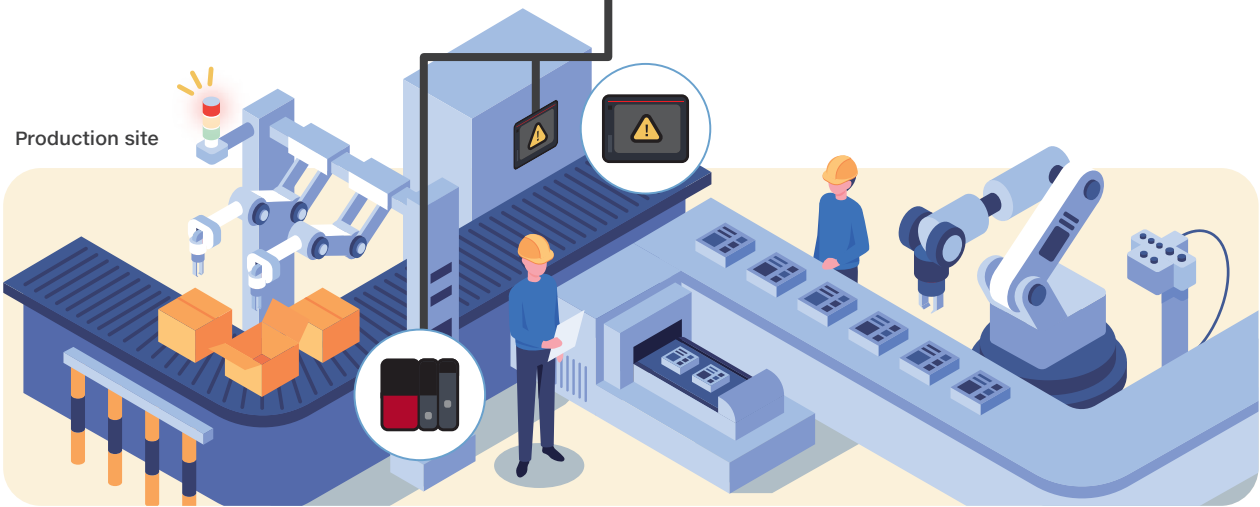Diagnosis results and data input to AI are shown in table format.

Office
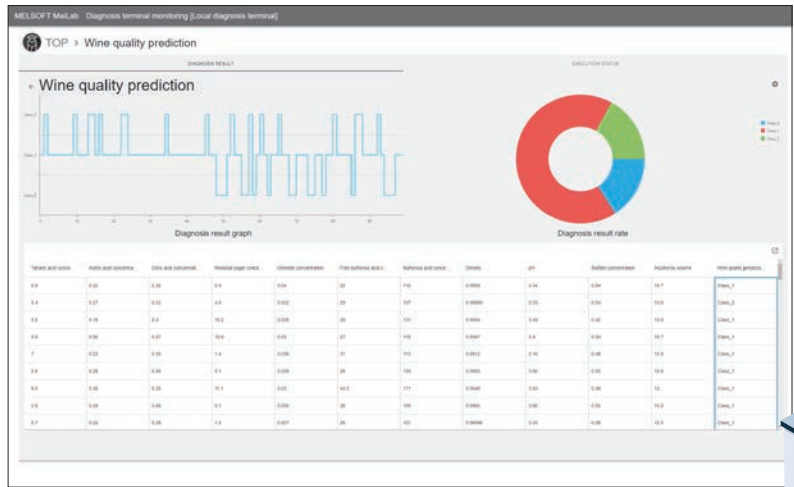
Learning server
MELSOFT
MaiLab

Find only
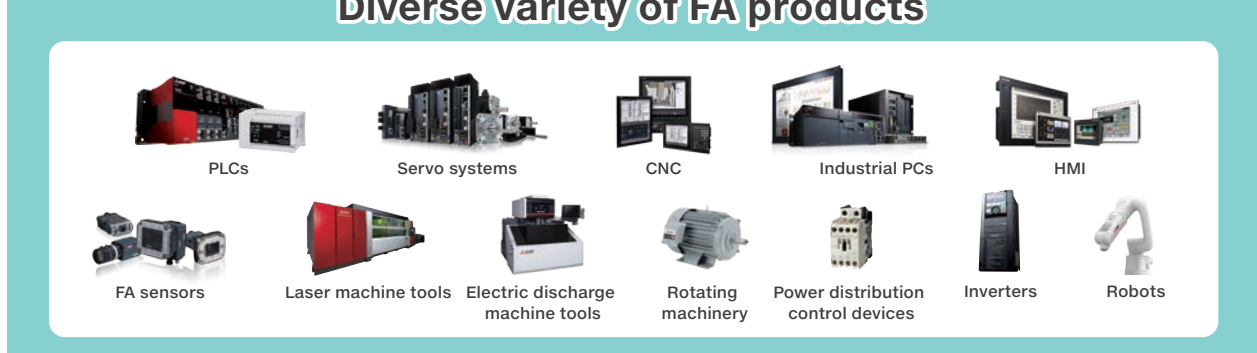abnormalities.

Production site

Try using it yourself.

For more information about MELSOFT MaiLab, please consult your local
Mitsubishi Electric representative.
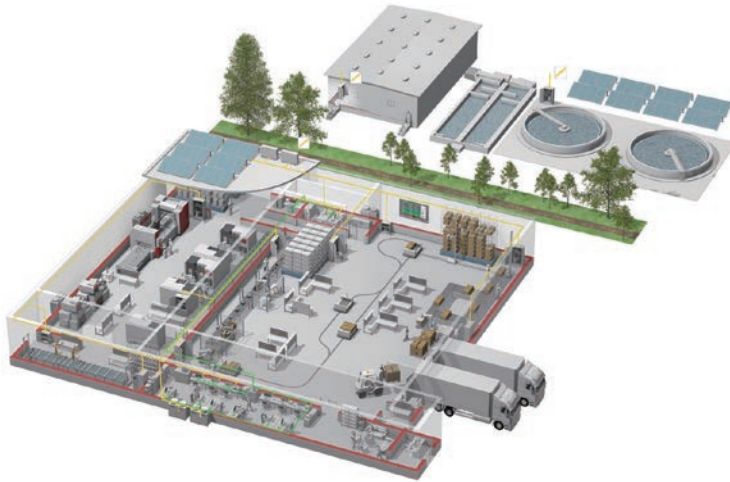
Digital Manufacturing by Mitsubishi Electric

Mitsubishi Electric contributes to the realization of digital manufacturing though its diverse variety of FA products and associated FA software products.

Design/development	Manufacturing	Operation/maintenance

MELSOFT MaiLab
Analysis/diagnosis environment that doesn't rely on skilled workers or their knowhow

Associated FA software products

MELSOFT Gemini
High-accuracy simulation environment

GENESIS64™
System monitoring environment for improved productivity

・Simulation
・Analysis/diagnosis
・Application/utilization

Data collection

Diverse variety of FA products

PLCs	Servo systems	CNC	Industrial PCs	HMI

FA sensors	Laser machine tools	Electric discharge machine tools	Rotating machinery	Power distribution control devices	Inverters	Robots

YOUR SOLUTION PARTNER

Mitsubishi Electric offers a wide range of automation equipment from PLCs and HMIs to CNC and EDM machines.

A NAME TO TRUST

Since its beginnings in 1870, some 45 companies use the Mitsubishi name, covering a spectrum of finance, commerce and industry.

The Mitsubishi brand name is recognized around the world as a symbol of premium quality.

Mitsubishi Electric Corporation, established in 1921, is active in space development, transportation, semi-conductors, energy systems, communications and information processing, audio visual equipment and home electronics, building and energy management and automation systems, and has 183 factories, laboratories and offices worldwide in over 140 countries.

This is why you can rely on Mitsubishi Electric automation solution - because we know first hand about the need for reliable, efficient, easy-to-use automation and control in our own factories.

As one of the world's leading companies with a global turnover of over 4 trillion Yen (over $40 billion), employing over 146,000 people, Mitsubishi Electric has the resource and the commitment to deliver the ultimate in service and support as well as the best products.

Low-voltage Power Distribution Products

Transformers, Med-voltage Distribution Products

Power Monitoring and Energy Saving Products

Power (UPS) and Environmental Products

Compact and Modular Controllers

Servos, Motors and Inverters

Visualization: HMIs

Edge Computing Products

Numerical Control (NC)

Collaborative and Industrial Robots

Processing machines: EDM, Lasers

* Not all products are available in all countries.

Sep. 2022