

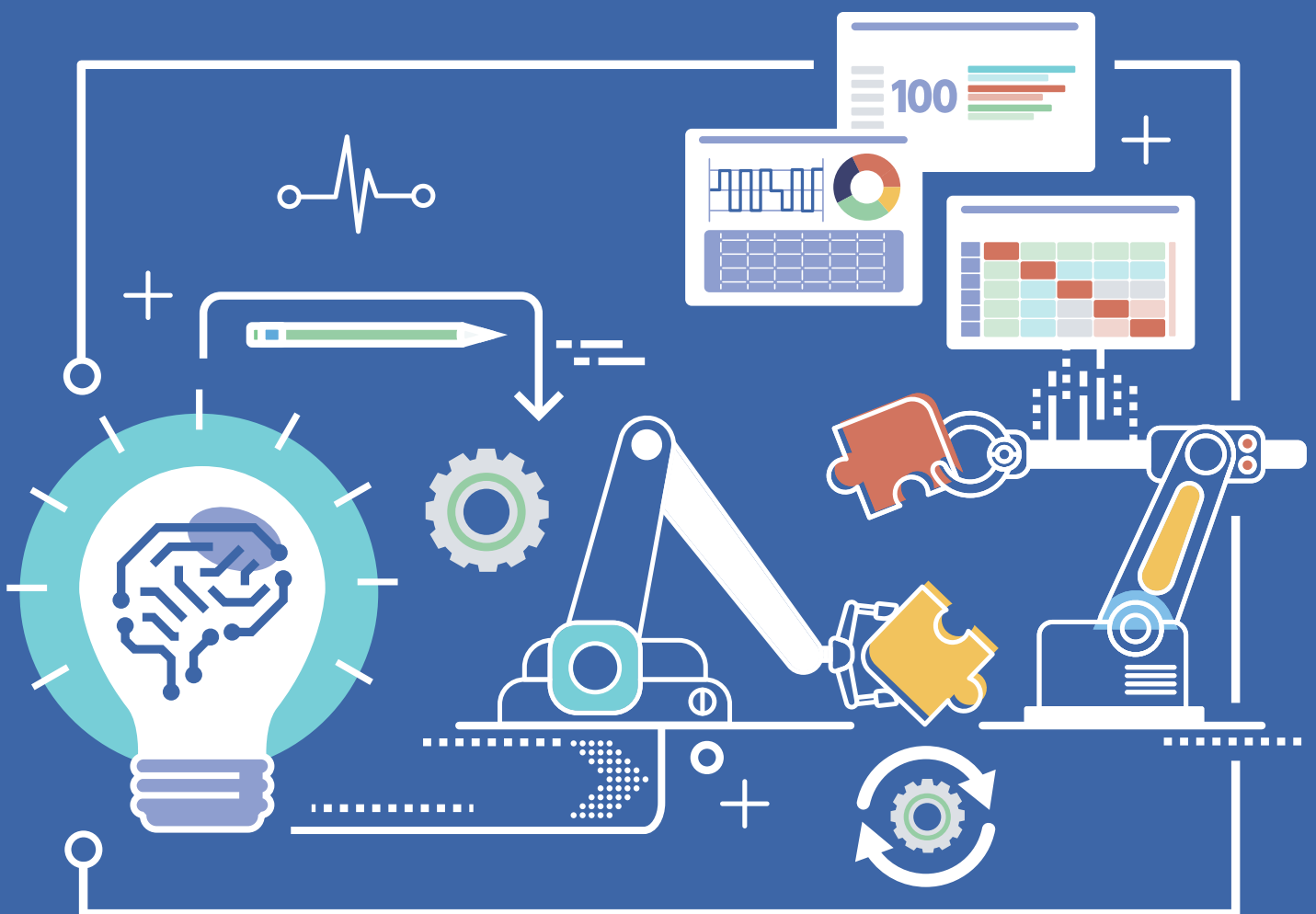
FACTORY AUTOMATION

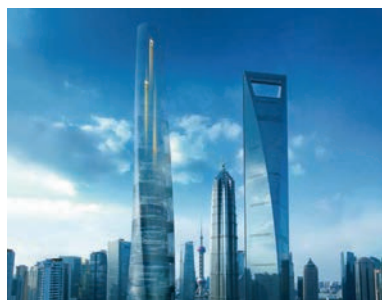
Mitsubishi Electric
Data Science Tool

MELSOFT MaiLab

e-Factory

 **Maisart**





Our Factory Automation business is focused on "Automating the World" to make it a better, more sustainable environment supporting manufacturing and society, celebrating diversity and contributing towards an active and fulfilling role.

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.



The Mitsubishi Electric Group is actively solving social issues, such as decarbonization and labor shortages, by providing production sites with energy-saving equipment and solutions that utilize automation systems, thereby helping towards a sustainable society.

Mitsubishi Electric Data Science Tool

MELSOFT MaiLab



INDEX

Mitsubishi Electric Data Science Tool MELSOFT MaiLab	4
Extensive Analysis Tools to Solve Various Challenges	
CASE 01: Diagnosing tool life from data to reduce costs	6
CASE 02: Passing on knowhow of skilled workers	8
System Configuration	
License format according to scale	10
Analysis Process	
Easy analysis/diagnosis in 4 steps	12
Offline Analysis	
Easy data upload and visual confirmation	14
Automatic learning based on your objectives	16
Customizable AI	18
Real-time Diagnosis	
Easy to apply the results to equipment	20
Digital Manufacturing by Mitsubishi Electric	22



MELSOFT Mailab

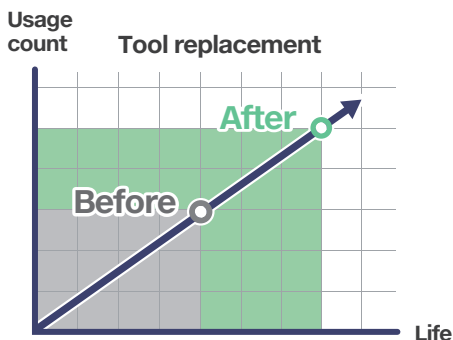
Even with the automation of equipment, there are still many processes that rely on the intuition and experience of on-site workers. By digitizing such knowledge, skill succession, dealing with labor shortages, cost reduction, improved productivity and quality, etc. can be achieved.

Challenge

Still relying on the experience and intuition of skilled workers

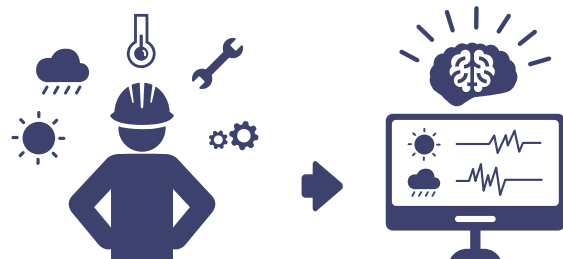
Cost reduction

Consumable replacement time is determined based on usage time and usage count, but replacement at the right time is not achieved. Can we replace them at the optimum timing by monitoring the consumable condition?



Skill succession and workforce saving

The input of manufacturing equipment parameters relies on the knowhow of skilled workers, and since this knowhow can't be documented, it's not easy to pass it on to young workers. Can the knowhow of skilled workers be passed on?



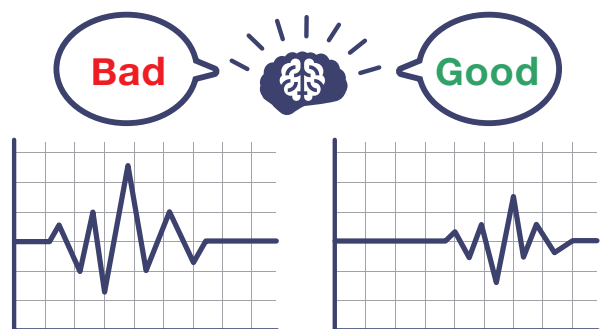
Improved productivity

Sudden breakdowns have reduced utilization rates and have not improved productivity. Can we perform maintenance before failure by monitoring equipment condition?



Improved quality

Although we check quality by having workers visually check data from the time of manufacture on a graph, there is variation from worker to worker, so there is no uniformity. Can quality be checked without relying on humans?



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

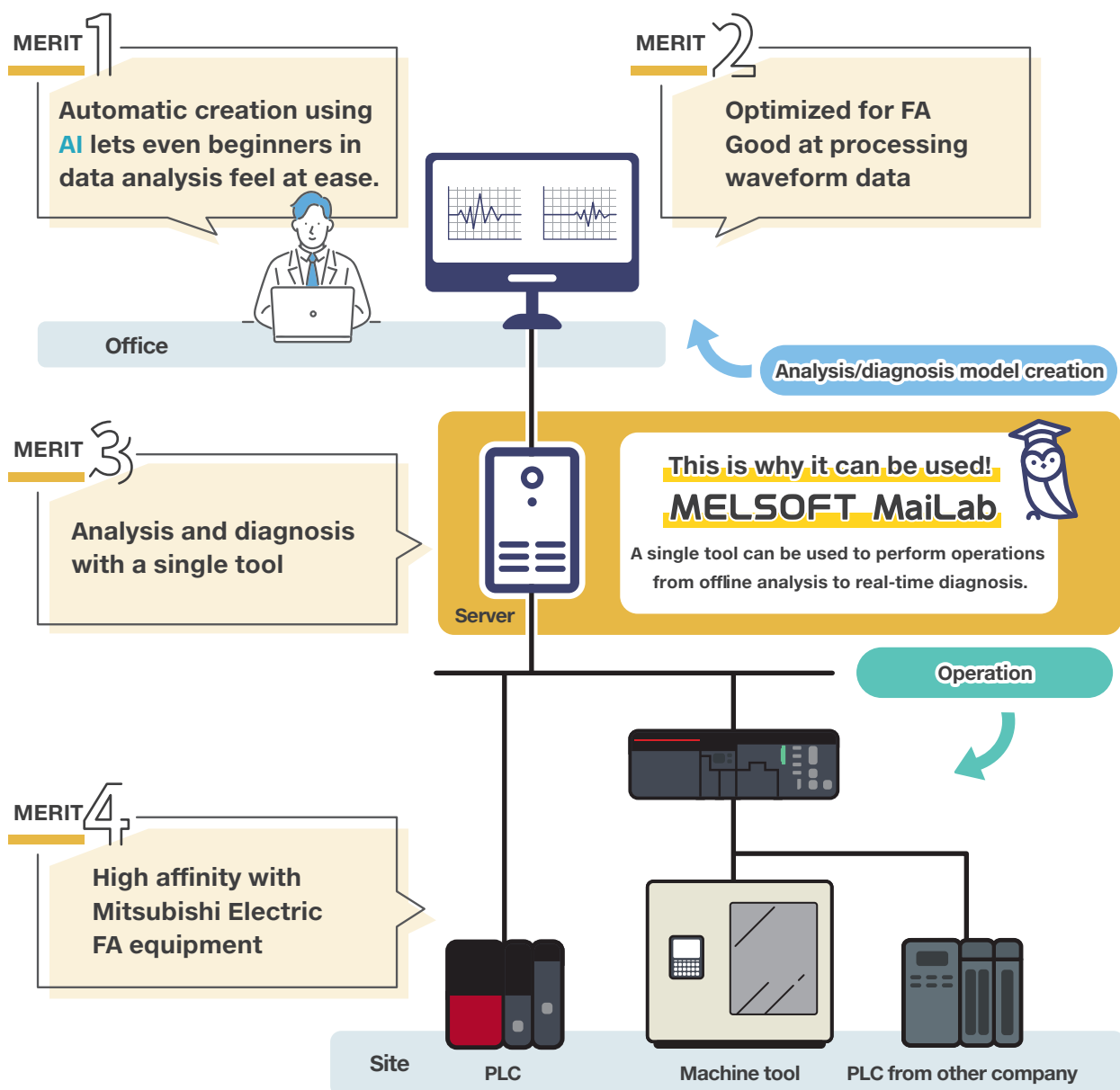
*Mitsubishi Electric's AI creates the State-of-the-ART in technology strategy.
Mitsubishi Electric's AI technology brand that aims to make all devices smarter.



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 making it easy to integrate into control systems.

Solution

Replace human experience with digital technology. Utilize data.



Diagnose tool life that is invisible.

Diagnosing tool life from data to reduce costs

Challenge

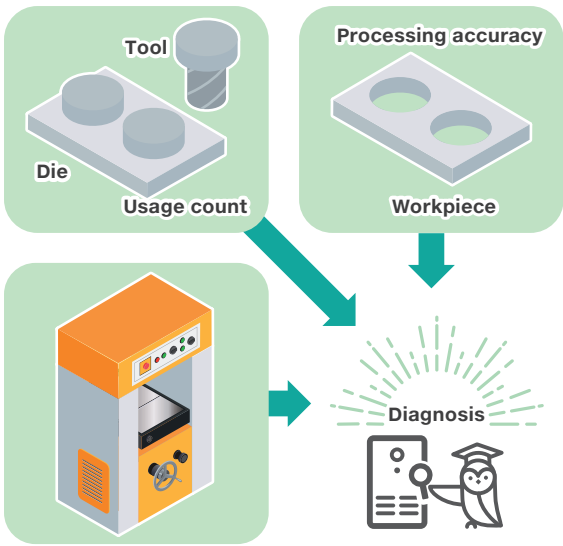
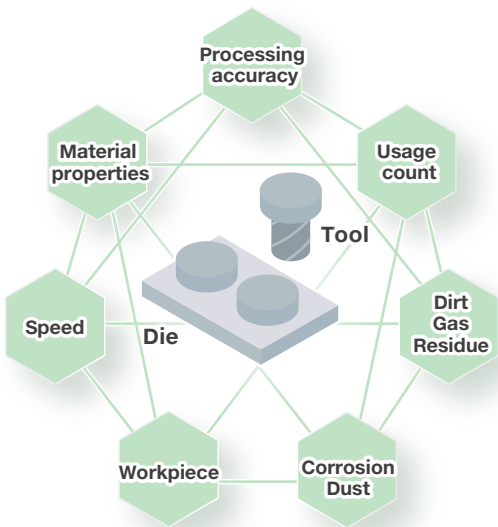
Tool life that can't be seen

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.



CASE 01

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

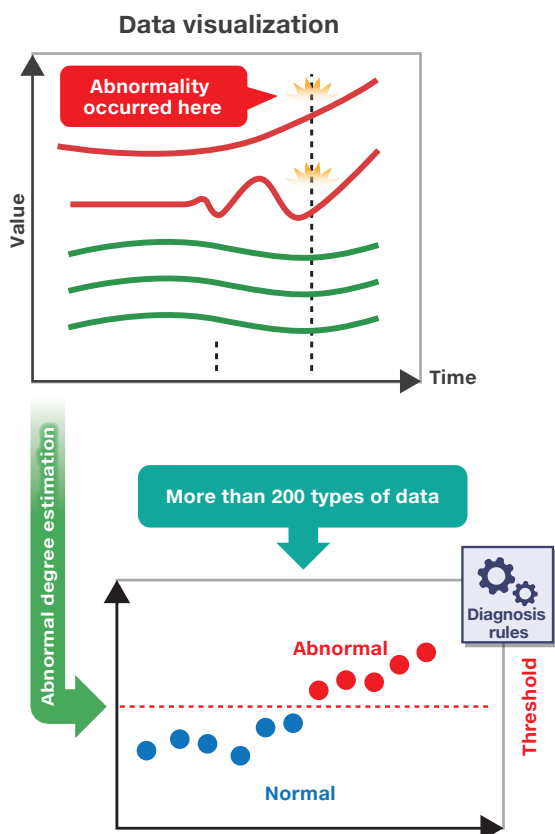
#Utilization ratio improvement

#Real-time diagnosis

AI-based solution

Finding optimum replacement timing

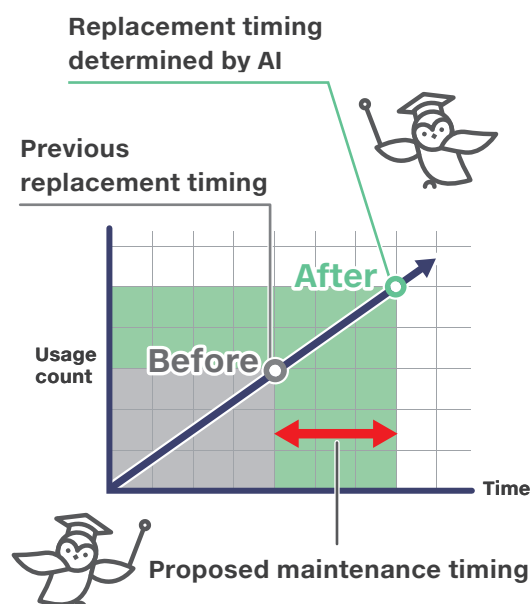
Monitors for signs of abnormalities to issue a warning of replacement or maintenance timing before failure occurs.



Cost reduction

Planned maintenance and reduced maintenance costs

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



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

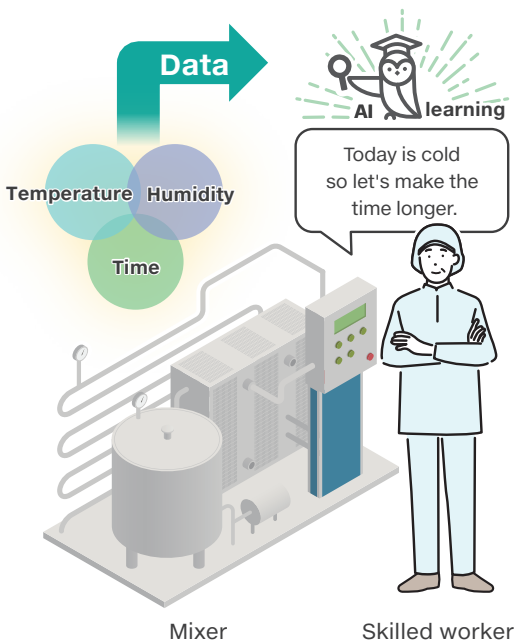
In the food production industry, work has been done relying on the skills of skilled workers to maintain constant quality, but there are concerns about the future.



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.



CASE 02

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

#Data utilization

#Digitalization

#Site DX

#Labor shortage

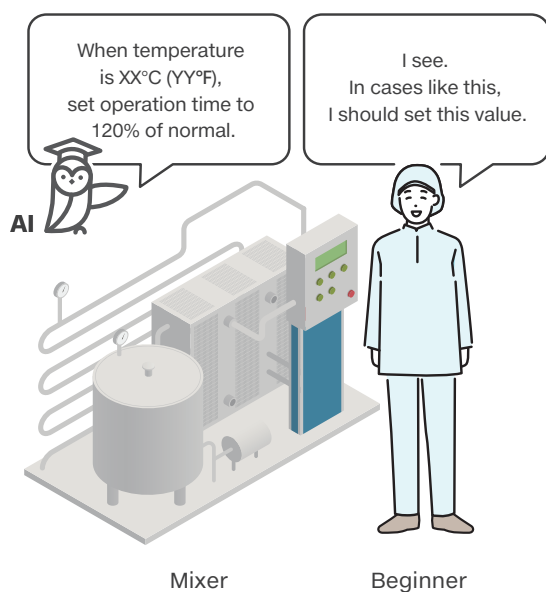
#Quality improvement

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

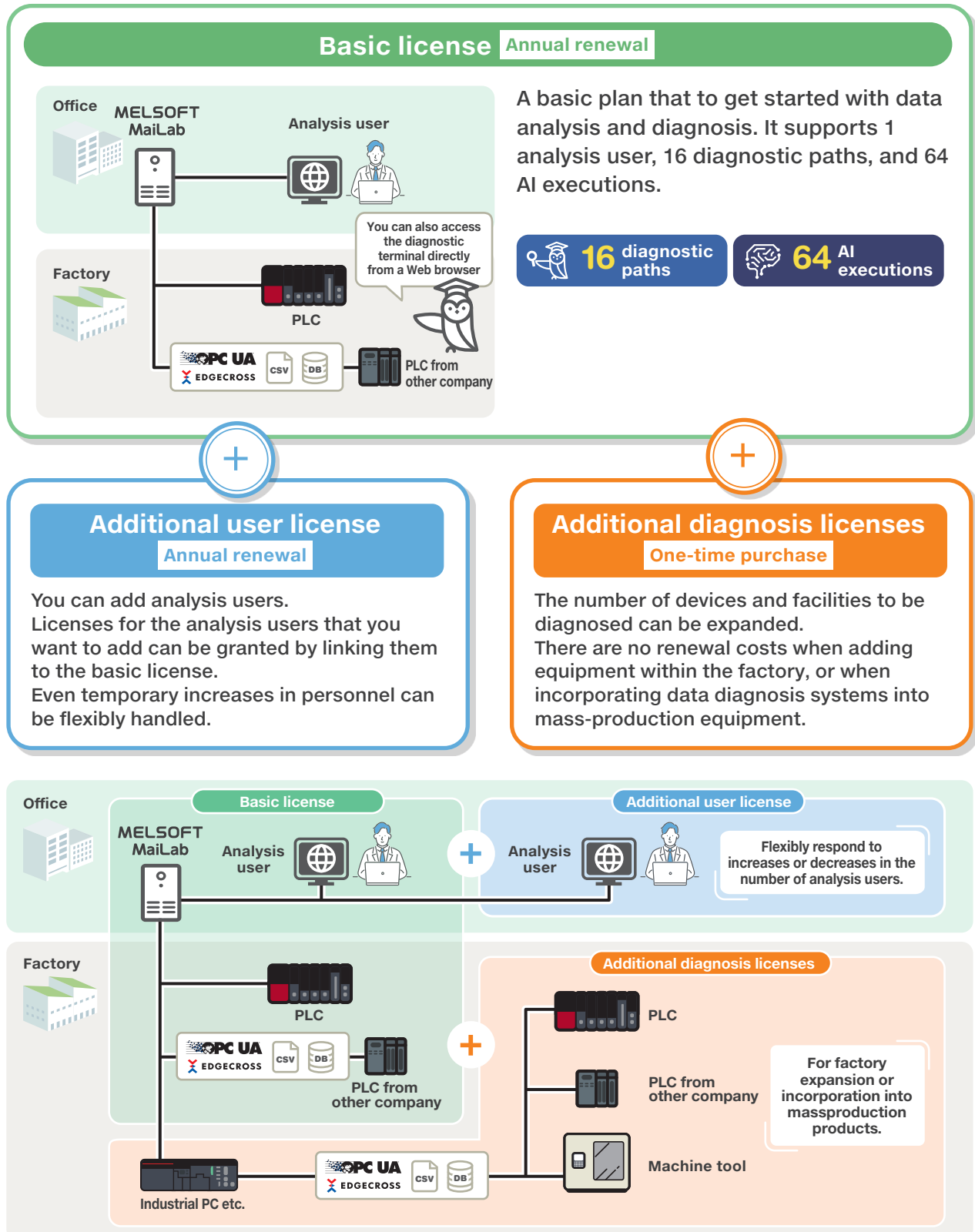
With a help of AI, beginners will gradually learn how to combine data that skilled workers have been doing, and someday they may surpass the skilled workers.





License format according to scale

In addition to the basic package license that enables analysis/diagnosis, additional licenses for extension functions are also available. Customers can consider the optimum plan according to their system scale.



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® 11 (Pro, Enterprise, IoT Enterprise) 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® 11 (Pro, Enterprise, IoT Enterprise) 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.
Graphic display makes it
easy to understand.

...P14



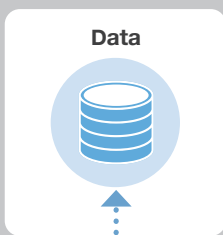
AI for automatic support.
Automatic AI creation from
what you want to do.

...P16

Data collection

Data collection

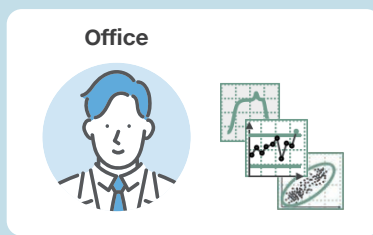
Examine what data
should be collected
and how they
should be collected.



Offline analysis

STEP 01 Data set creation

First, read the data to be analyzed
into MELSOFT MaiLab and upload
them. A group of uploaded 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 accumulation

Production site



and more



Need more accuracy?
You can customize
your AI in MaiLab.
...P18



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



Easy collaboration with the
production site.
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 defines the data input/output methods and thresholds for determining OK/NG diagnostic results. Accuracy is displayed as a score to guide the decision.



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.

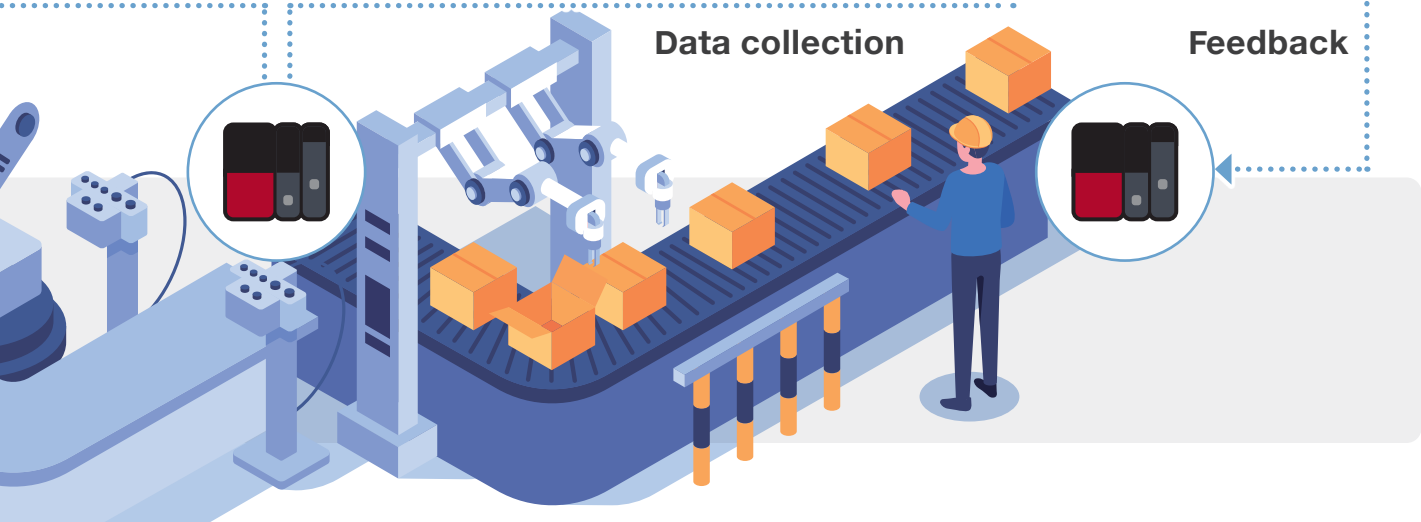


Office



Data collection

Feedback





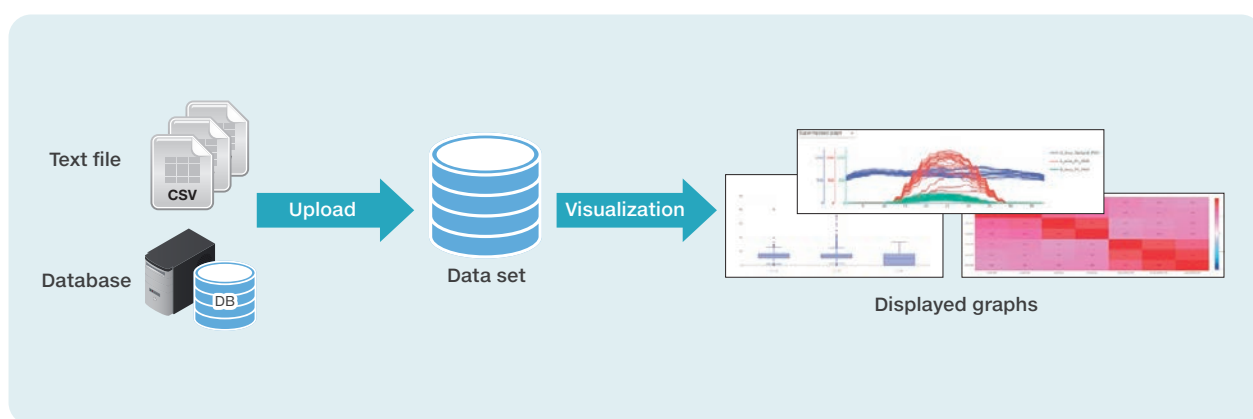
Easy data upload and visual confirmation

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 upload the data subject to analysis in MELSOFT MaiLab. A group of uploaded data is called a "data set". By the uploaded data set, the data can be visualized in tables or graphs, and diagnosis models can be created.



■ Data can easily be uploaded from a text file or database.

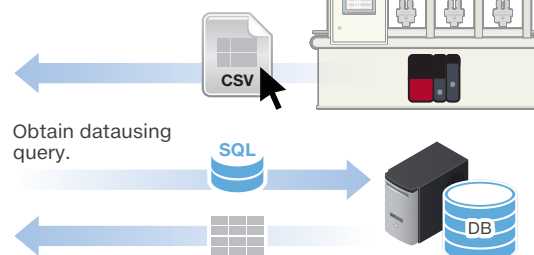
The original source of the data to be uploaded as a data set is called a "data source". Data sources that can be uploaded are text files in CSV and TSV formats and databases*.

*MySQL, SQL Server, and PostgreSQL are supported.

Label ID	Target value	Acetic acid	Chlorogenic acid	Malic acid	Residual sugar	Free sulfuric acid	Total sulfuric acid	Density	pH	Residual sugar	Wine quality
Label ID	Target value	Acetic acid	Chlorogenic acid	Malic acid	Residual sugar	Free sulfuric acid	Total sulfuric acid	Density	pH	Residual sugar	Wine quality
1	0.1	0.07	0.08	0.05	0.05	0.05	0.05	1.000	3.5	0.05	0.05
2	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.995	3.5	0.05	0.05
3	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.995	3.5	0.05	0.05
4	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.995	3.5	0.05	0.05
5	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.995	3.5	0.05	0.05
6	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.995	3.5	0.05	0.05
7	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.995	3.5	0.05	0.05
8	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.995	3.5	0.05	0.05

Uploaded data can be easily visualized.

Drag and drop the CSV-format data source.



■ Let's look at the uploaded data in various ways.

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



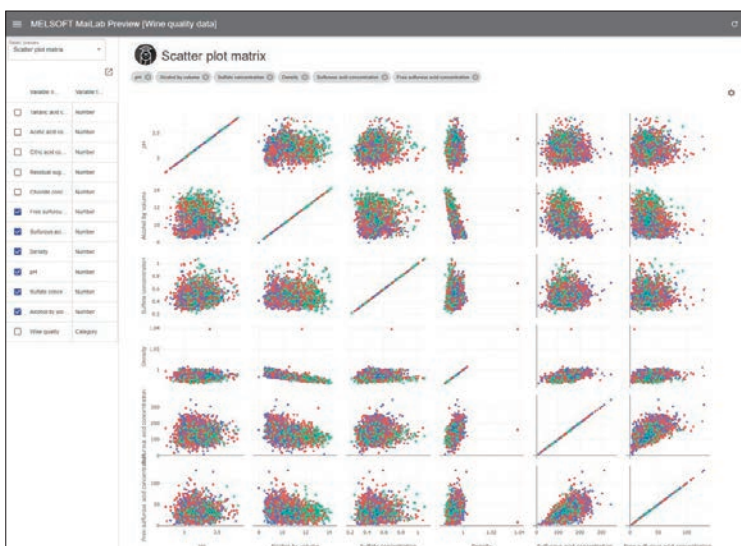
Line chart and histogram



Pie chart and histogram



Correlation matrix heat graph



Scatter plot matrix



Automatic learning based on your objectives

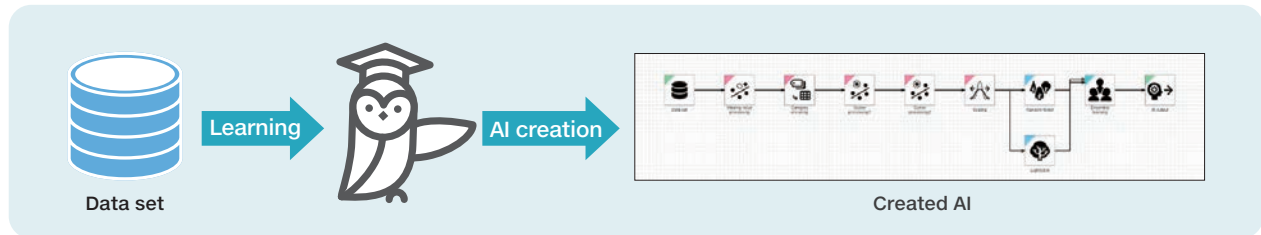
You can create the optimum diagnosis.

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.



Easy because it's interactive. No hassle with automatic AI creation.

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).

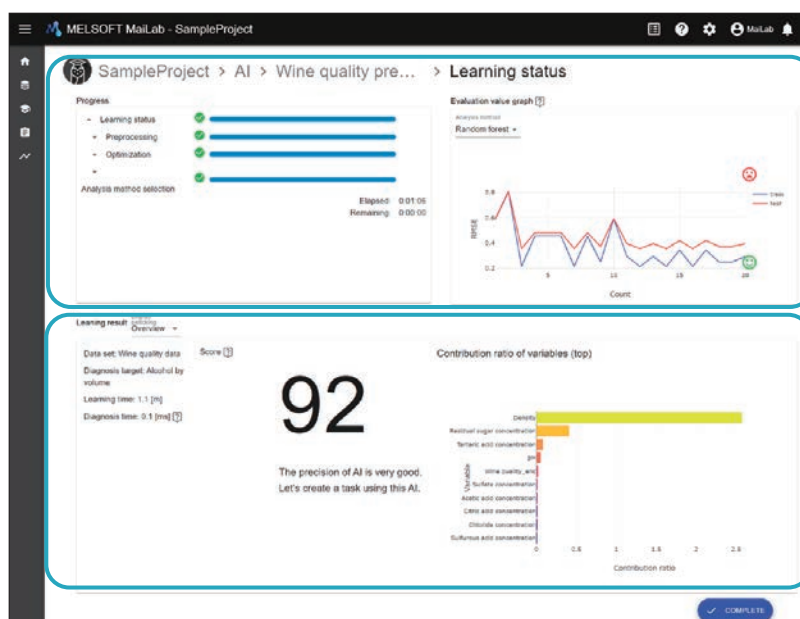
Manual

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.

The 'Create new AI' dialog box shows the following fields and options:

- Name:** Wine quality prediction
- Data set:** Wine quality data
- How to Create:** Radio buttons for 'Auto' (selected) and 'Manual'.
- Icons:** Two owl icons, one with a star and one with a pencil.
- Buttons:** 'FORWARD' and 'CANCEL'.

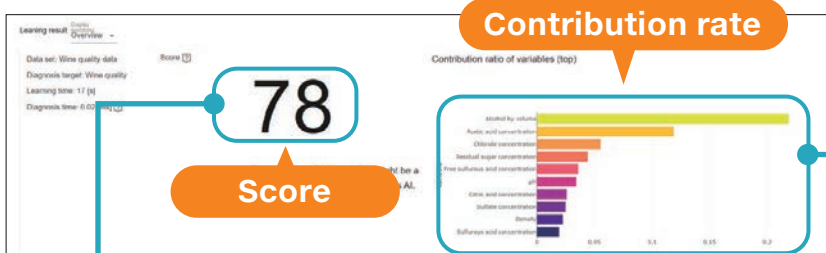
Then leave it to Mailab. Wait for the learning results.



When setting of objectives and methods has been completed, Mailab 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.**

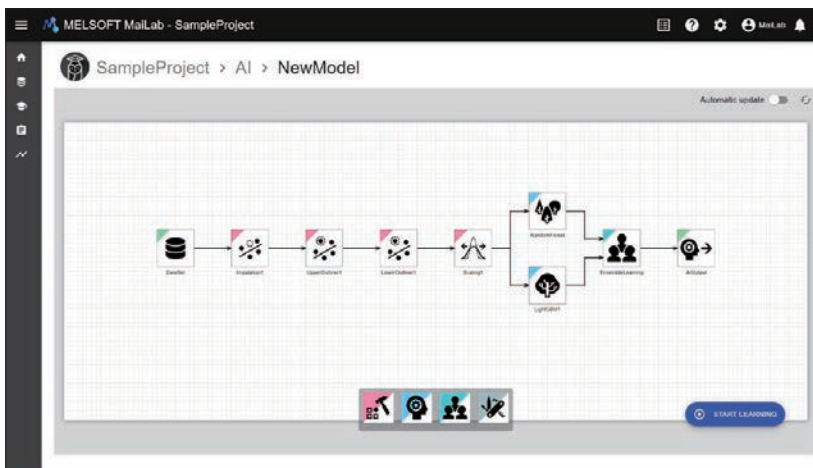
*When the scores are low, you can review the learning level and judge whether to perform re-learning, etc.

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.

When learning is complete, AI is complete.



When the learning is complete, the AI creation will be completed and the blocks representing each process of the AI will be placed.

You can manually change the completed AI to customize it to increase reliability.



Perform AI test.



Perform AI test for verifying the diagnosis results by any data set.

The accuracy of the AI can be verified, and improvement methods can be studied.





Customizable AI

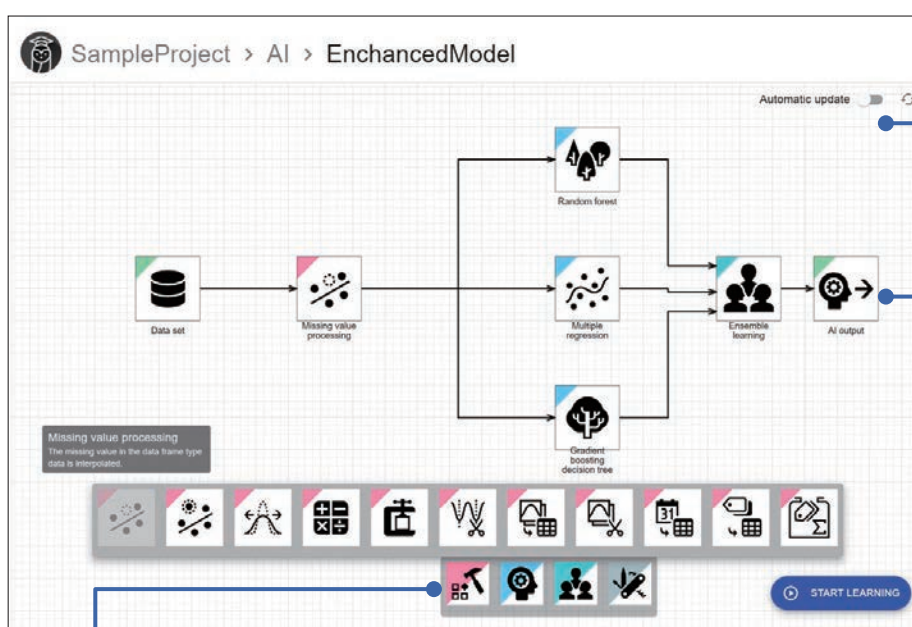
You can also freely create AI models with higher accuracy.

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.

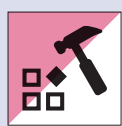


Canvas

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 to perform the desired processing in AI.



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.

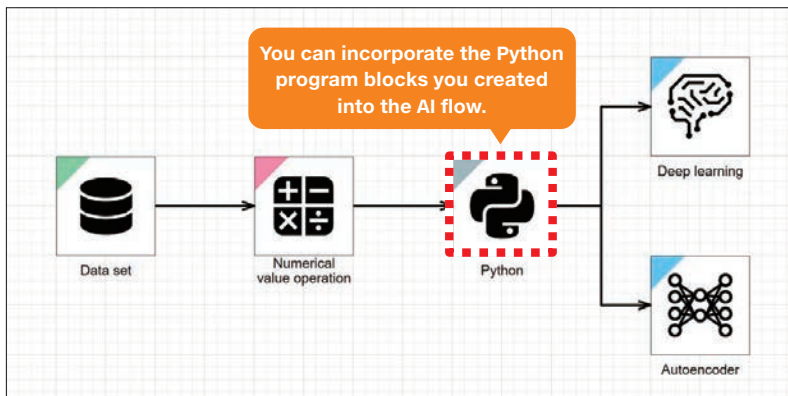


Utility category

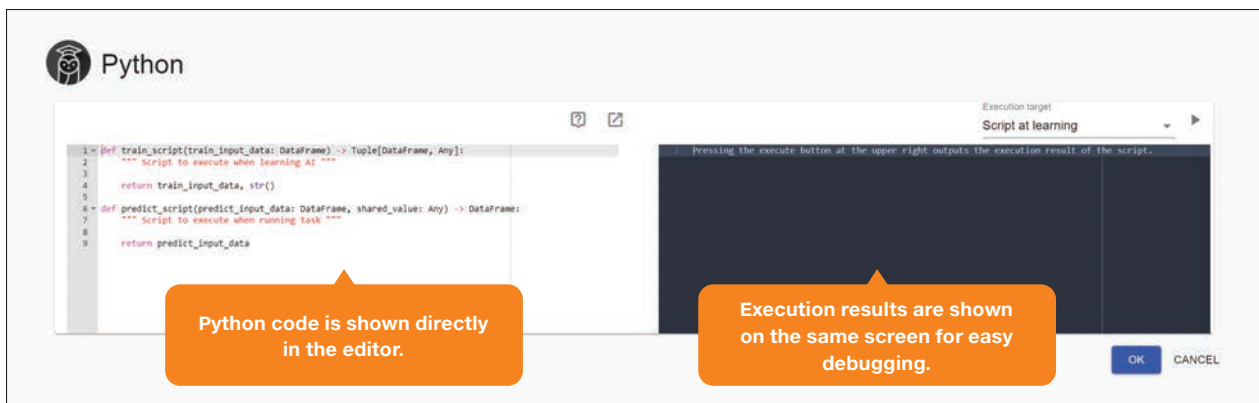
Includes blocks that can be placed at various places in the processing flow for various purposes such as changing processing content or input/output, etc.

■ 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.



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 a new feature.





Easy to apply the results to equipment

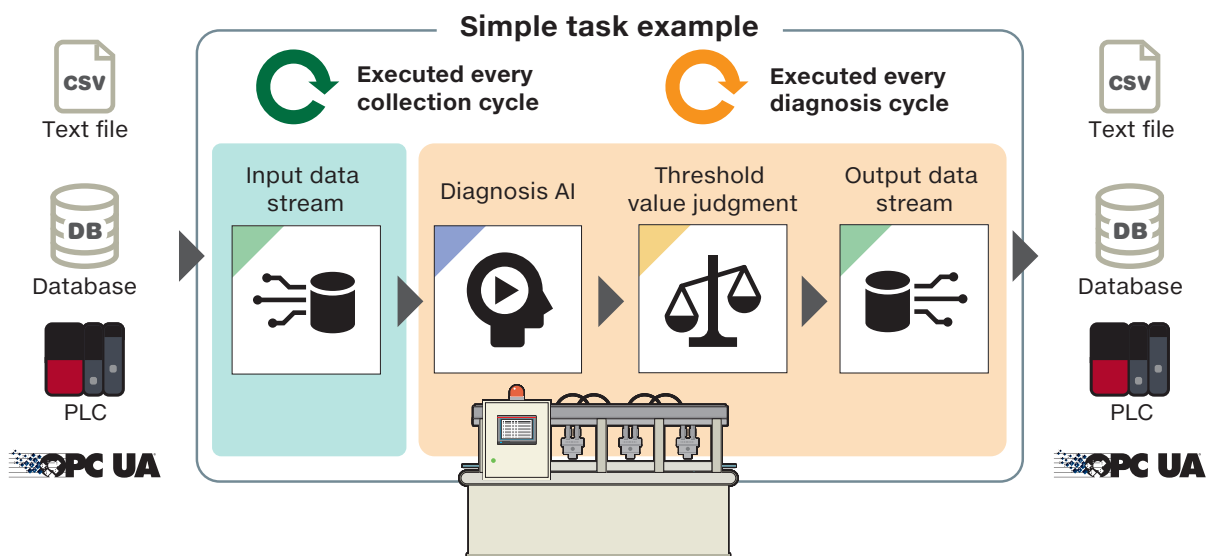
Corporation with the production site at the touch of a button and start of real-time diagnosis.



Implementing in the equipment (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.



*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 Device 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.

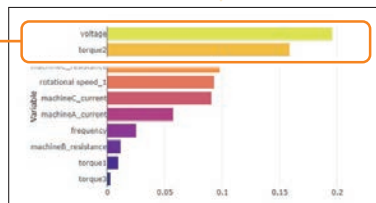
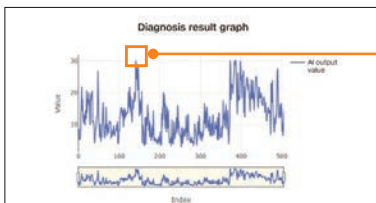


Diagnosis results are shown in Line chart and Pie chart.

Diagnosis results and data input to AI are shown in table format.



Past diagnosis results can be displayed using the historical monitor function. In addition, the historical monitor function can be used to check the AI diagnosis basis for the diagnostic results.



AI diagnosis basis



A numerical value (contribution rate) is displayed that indicates the degree of influence of each explanatory variable on the diagnosis results. By reviewing the variables that influenced the diagnosis results, causes can be identified and suggestions for improvement can be obtained when an abnormality or defect occurs.

Learning server
MELSOFT
MaiLab

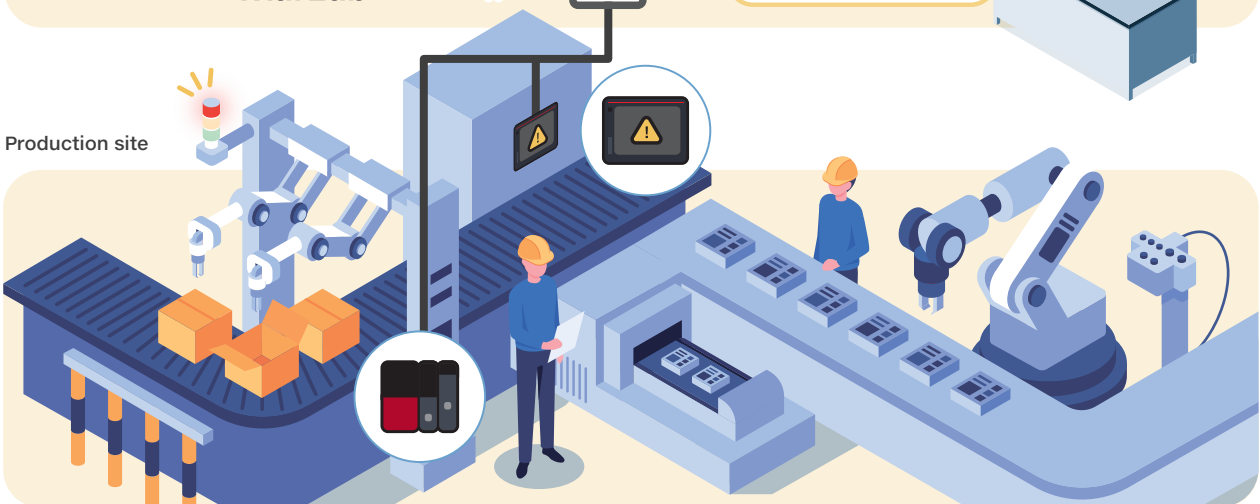


Abnormality found!

Office



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 through its diverse variety of FA products and associated FA software products.



Trademarks and Registered Trademarks

- Celeron, Intel, and Pentium are either registered trademarks or trademarks of Intel Corporation in the United States and/or other countries.
- Microsoft and Windows are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.
- OPC UA and OPC CERTIFIED logo are registered trademarks of OPC Foundation.
- This product includes software developed by the OpenSSL Project for use in the OpenSSL Toolkit (<http://www.openssl.org/>)
- This product includes software derived from the RSA Data Security, Inc. MD5 Message-Digest Algorithm
- The company names, system names and product names mentioned in this document are either registered trademarks or trademarks of their respective companies.
- In some cases, trademark symbols such as "™" or "®" are not specified in this document.

Creating Solutions Together.



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



SCADA, analytics and simulation software

Mitsubishi Electric's product lineup, from various controllers and drives to energy-saving devices and processing machines, all help you to automate your world. They are underpinned by software, innovative data monitoring, and modelling systems supported by advanced industrial networking and Edgecross IT/OT connectivity. Together with a worldwide partner ecosystem, Mitsubishi Electric factory automation (FA) has everything to make IoT and Digital Manufacturing a reality.

With a complete portfolio and comprehensive capabilities that combine synergies with diverse business units, Mitsubishi Electric provides a one-stop approach to how companies can tackle the shift to clean energy and energy conservation, carbon neutrality and sustainability, which are now a universal requirement of factories, buildings, and social infrastructure.

We at Mitsubishi Electric FA are your solution partners waiting to work with you as you take a step toward the realization of sustainable manufacturing and society through the application of automation. Let's automate the world together!



MITSUBISHI ELECTRIC CORPORATION

HEAD OFFICE: TOKYO BLDG., 2-7-3, MARUNOUCHI, CHIYODA-KU, TOKYO 100-8310, JAPAN

www.MitsubishiElectric.com