Toward the Fourth Industrial Revolution, the challenge of transforming manufacturing with AI

～ Introduction and future development of IoT data analysis using deep learning ～

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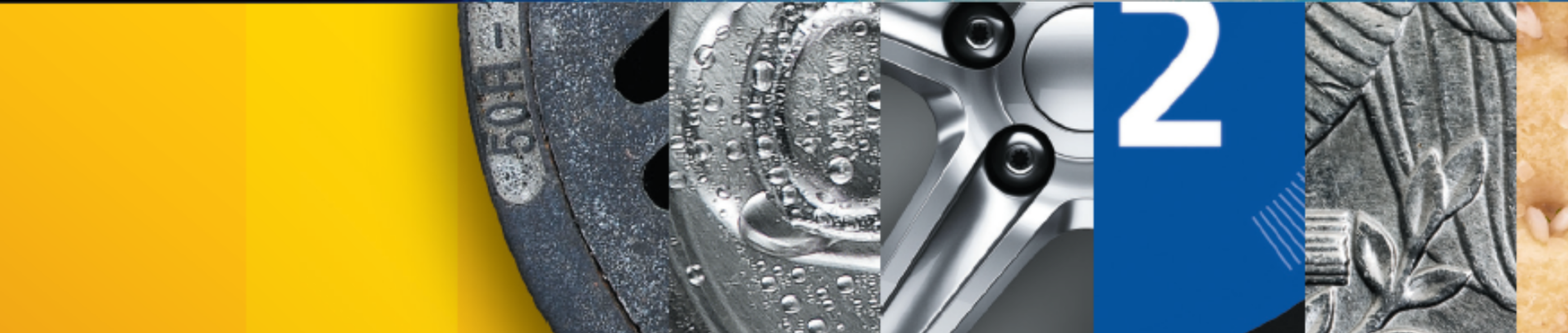
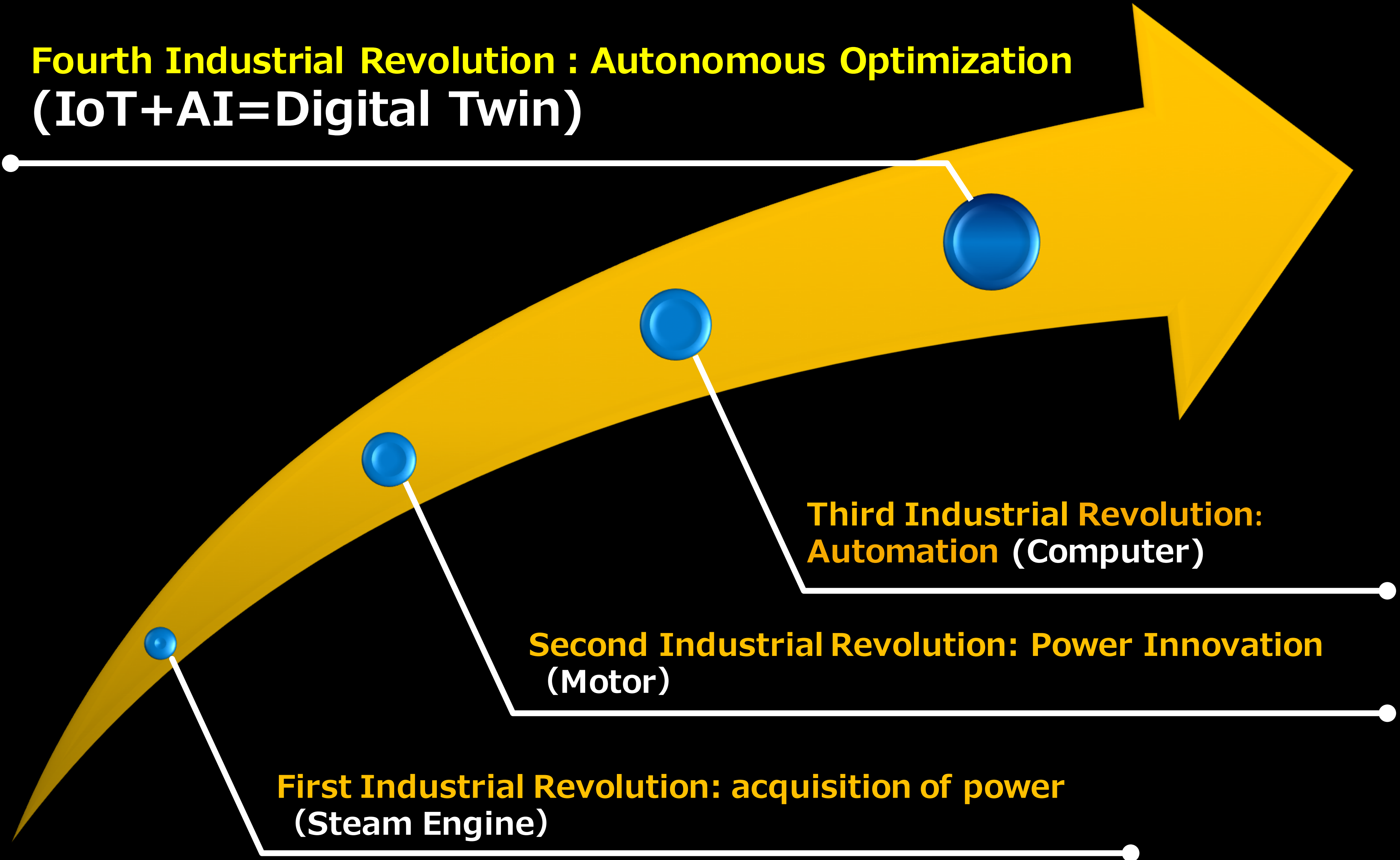
NTT Communications
Technology Development Division
Kenichiro Shimada



Fourth Industrial Revolution



Challenges facing the manufacturing industry

Superior human resources (craftsman) are
the source of Japan's competitiveness.

Quality improvement、
Cost Reduction

Declining birthrate
and aging population

Wave of the 4th Industrial
Revolution accelerating overseas

What's happening in manufacturing around the world?

Siemens 『Mind Sphere』

Cloud-based IoT OS.Integrated with IBM's AI "Watson", it collects and analyzes information collected from machine tools installed in plants and factories to predict machine failures and optimize production.

GE 『 Brilliant Factory 』

Leverages data in real time with the latest digital technologies, from manufacturing operations to the supply chain 'Optimize'

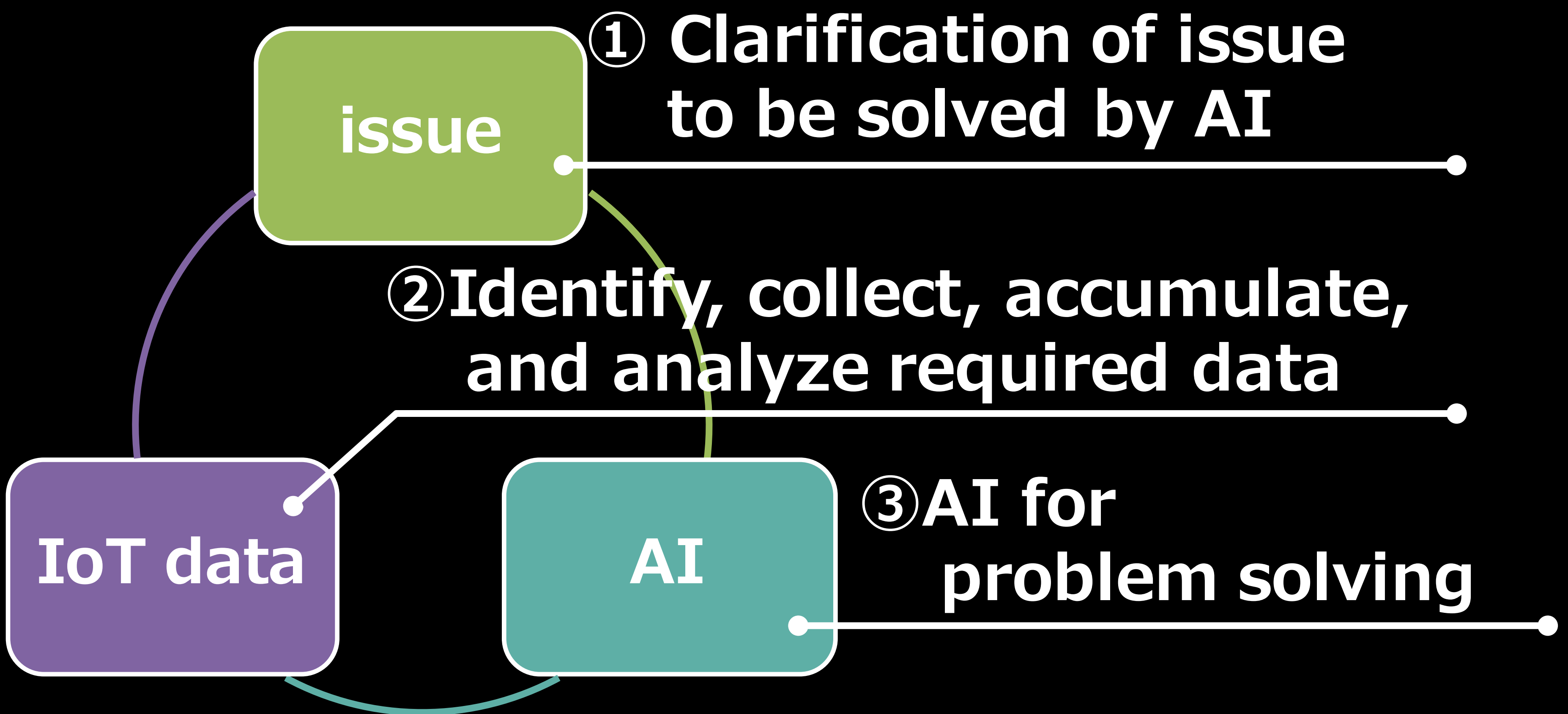
Chinese government『中国製造2025 』

expedite the development of a system to realize a "smart manufacturing" that optimizes production processes by processing large data in real time from plant operations

Toyota『Material development using AI』

Established a subsidiary and base for AI development (TRI) in Silicon Valley. Using AI, we are developing new materials for batteries and catalysts for fuel cells.

Three factors to consider when applying AI to manufacturing



It is necessary to select the appropriate AI according to the issue to be solved and the available IoT data

IoT Data in Manufacturing

①Confidentiality

In many cases, the data includes production know-how.

②Time-series

Finding hidden meaning in time-varying data

③Multimodal

Combine multiple types of data to find meaning

Need data management techniques and AI algorithms for confidentiality, time series, and multi-modal

Method of determining the AI algorithm

Business issue

①Regression
predict the level of concentration etc.

②Classification
male or female/ animal, etc.

③Anomaly Detection
to distinguish defective goods,etc.

④Automatic Control
control a robot, etc.

⑤Generating
draw picture, compose music etc.

⑥Transfer
changing tone of voice, translation etc.

×

IoT Data

①Picture/Movie
drive recorder picture, etc.

②Sound
motor sound etc.

③language
manual etc.

④Sensor data
process data etc.

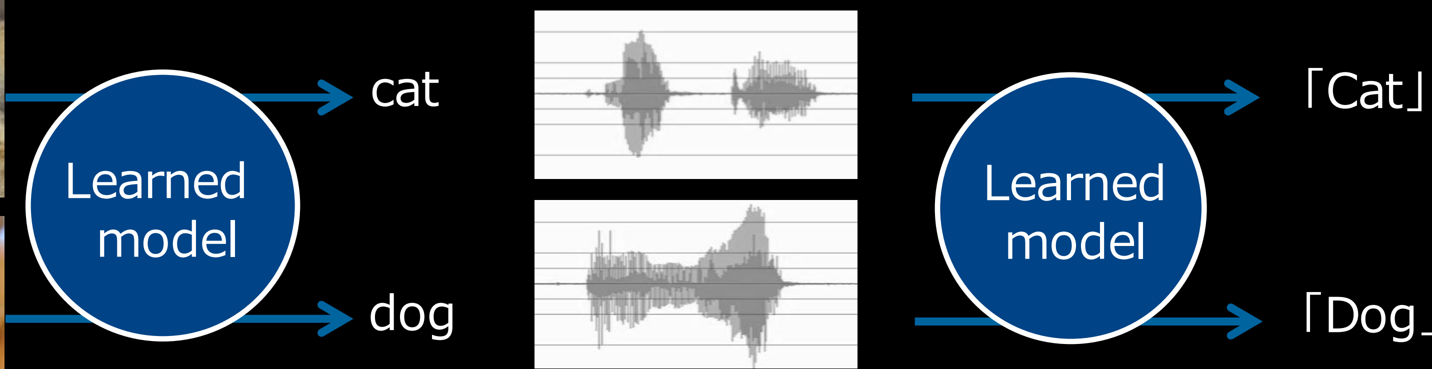
⑤Combination of the above
picture × sound × sensor etc.

※Depend on the quality and quantity of data

Development of algorithms suitable for issues and data

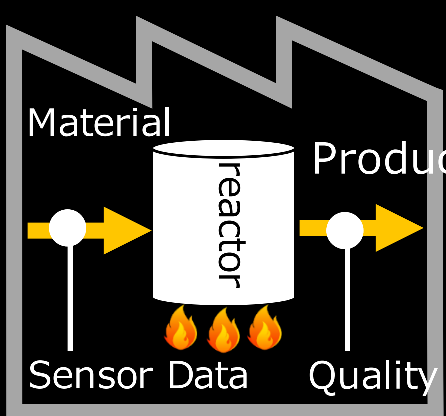
Problems when trying to solve manufacturing issue 1/3

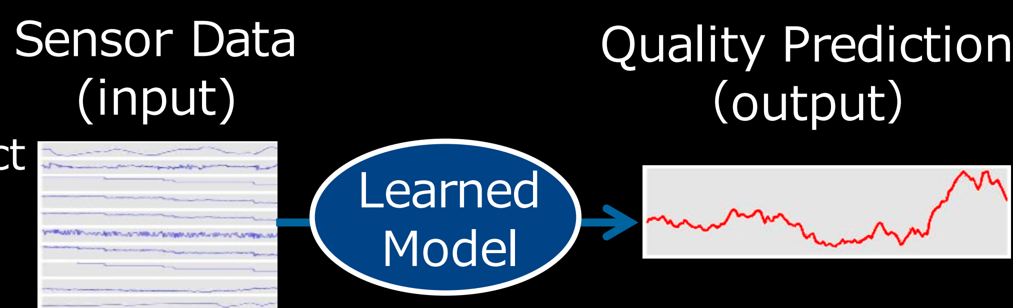
Image, speech recognition,NLP, etc.



It can be reused as it is or fine tuning (additional learning).

Quality prediction / anomaly detection using IoT data





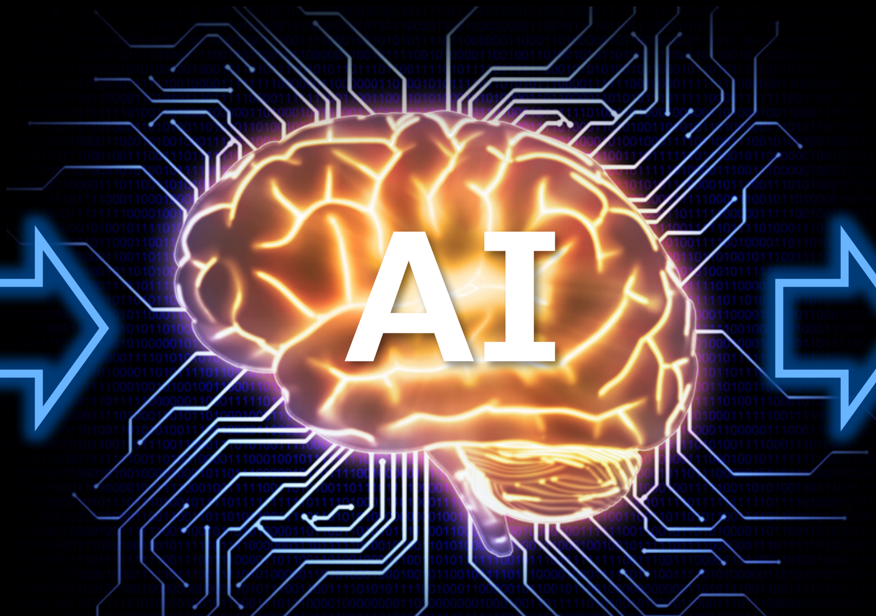
Difficult to reuse learned models due to “different I/O types or numbers” and “modelling targets” ➡ reuse “know-how”

Each work requires data preparation/design/learning and does not necessarily lead to resolution of the issue

Problems when trying to solve manufacturing issue 2/3

Input

temp
pressure
flow rate
・
・
・
composition



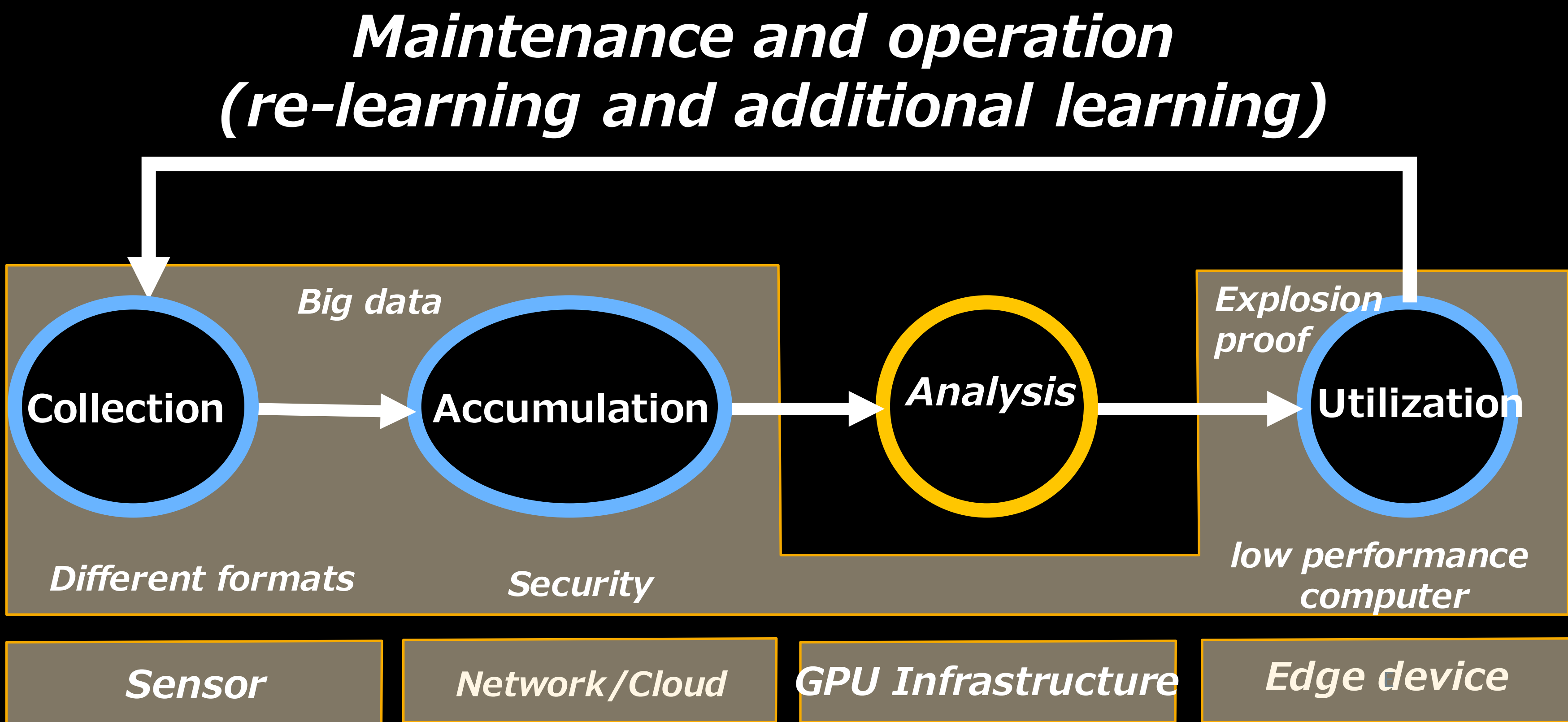
Output

Quality
after X minutes

Complex,Nonlinear

The relationship between input and output is unknown (Black Box), and it is not possible to obtain guidelines for improvement of operation.

Problems when trying to solve manufacturing issue 3/3



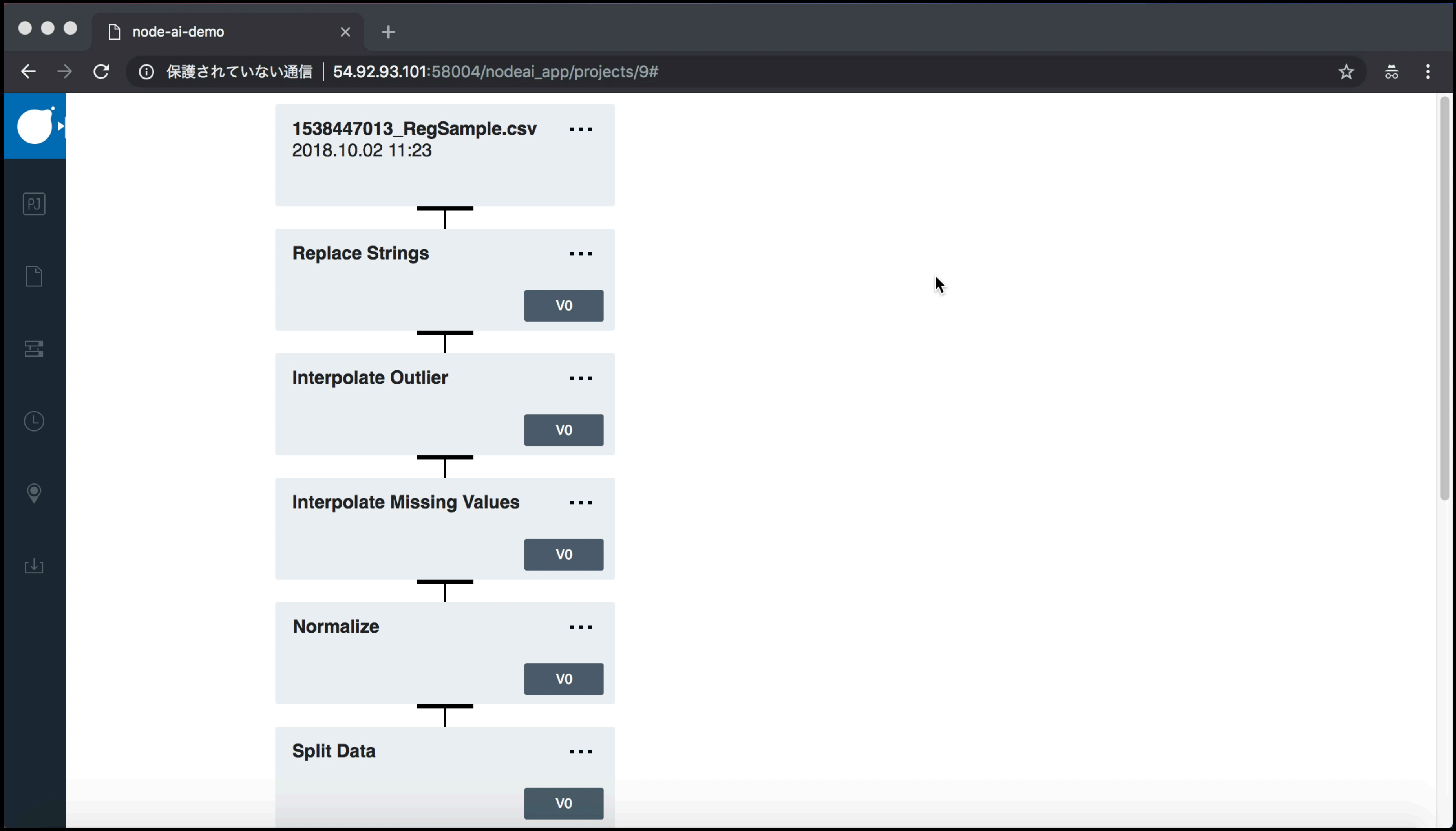
Combining and systematizing IoT and AI
with the knowledge and know-how of the field
is important.

IoT×AI works
of NTT Communications

The solution for Problem 1
AI X IoT Development Support Tools

Node-AI

Node-AI

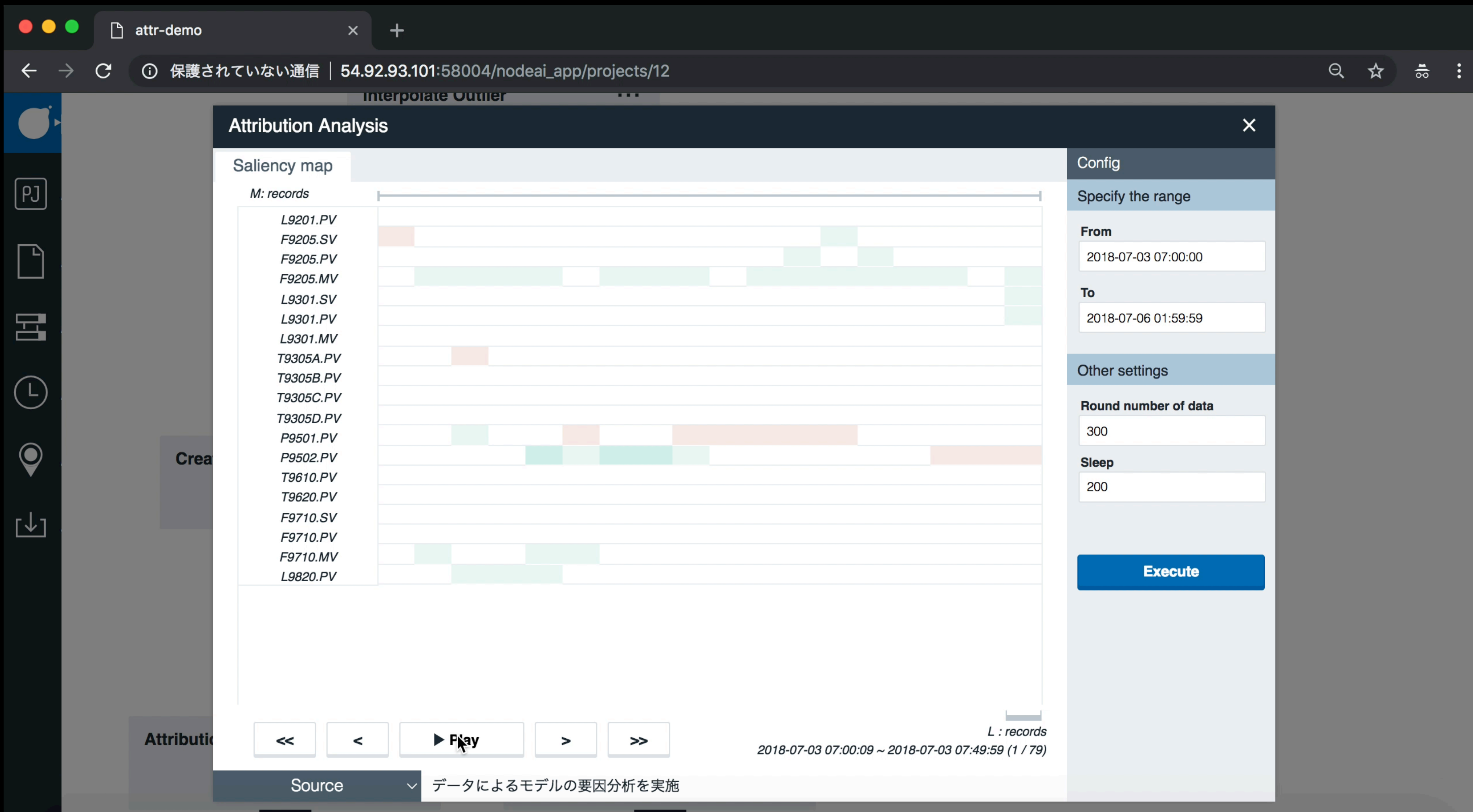


node-ai-demo
保護されていない通信 | 54.92.93.101:58004/nodeai_app/projects/9#
1538447013_RegSample.csv
2018.10.02 11:23
Replace Strings
V0
Interpolate Outlier
V0
Interpolate Missing Values
V0
Normalize
V0
Split Data
V0

The solution for Problem 2
Visualization of attribution

Node-AI

Node-AI


attr-demo
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Attribution Analysis
Saliency map
M: records
L9201.PV
F9205.SV
F9205.PV
F9205.MV
L9301.SV
L9301.PV
L9301.MV
T9305A.PV
T9305B.PV
T9305C.PV
T9305D.PV
P9501.PV
P9502.PV
T9610.PV
T9620.PV
F9710.SV
F9710.PV
F9710.MV
L9820.PV
<<
<
Play
>
>>
L : records
2018-07-03 07:00:09 ~ 2018-07-03 07:49:59 (1 / 79)
Config
Specify the range
From
2018-07-03 07:00:00
To
2018-07-06 01:59:59
Other settings
Round number of data
300
Sleep
200
Execute
Source
データによるモデルの要因分析を実施

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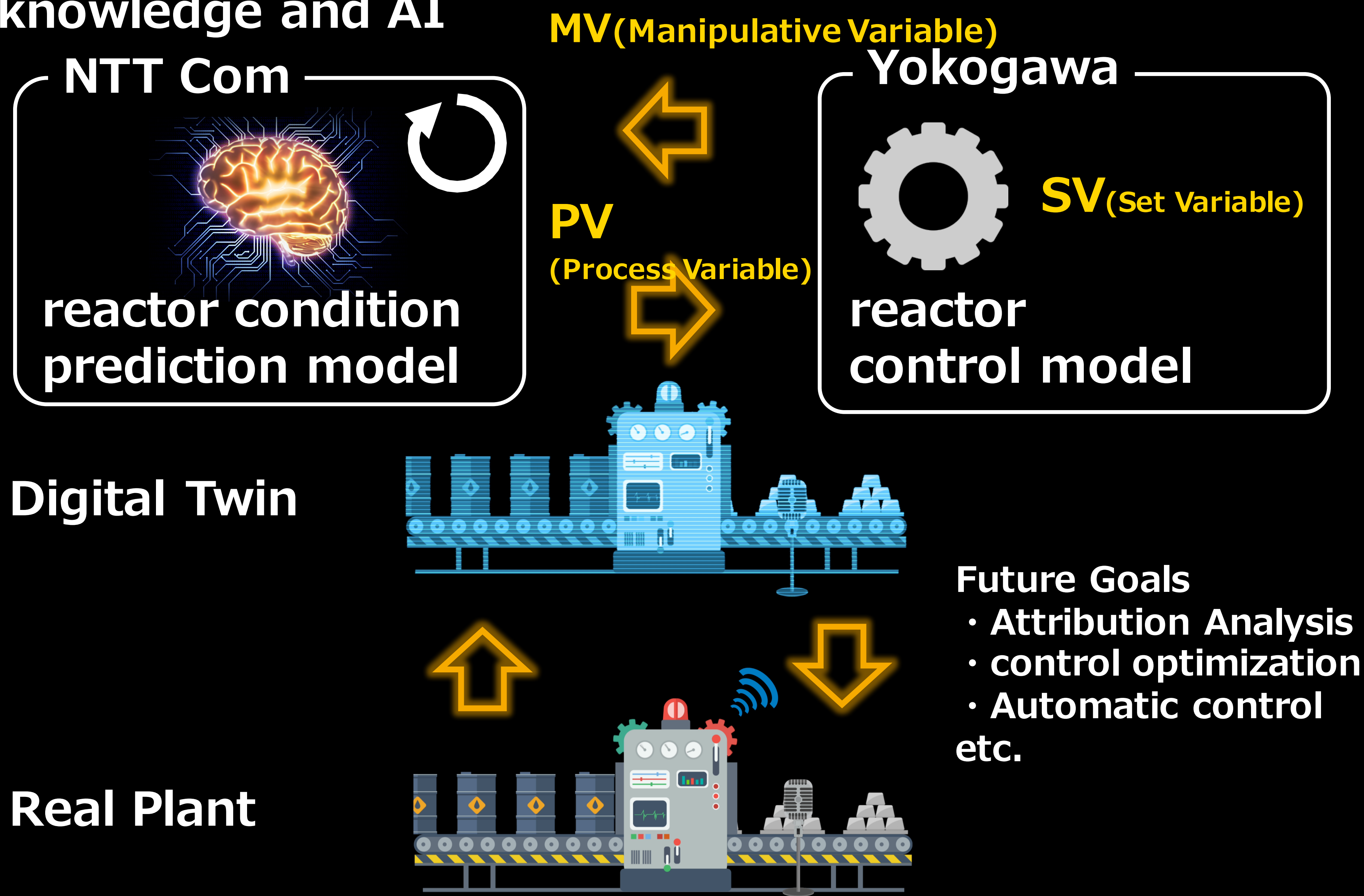
+

YOKOGAWA

Production process modeling that combines on-site knowledge and AI



Future Developments

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NCS

Data Analysis using multimodal Deep Learning

Drive Recoder Data
Time-series multimodal data)

Training Data : 600、Test data : 250

- Movie data
- Sensordata (Speed、Acceleration)
- Sound data

Multimodal
Deep Learning

result

accident/near miss/non near miss

Movie＋ Sensor(Speed＋Acceleration)

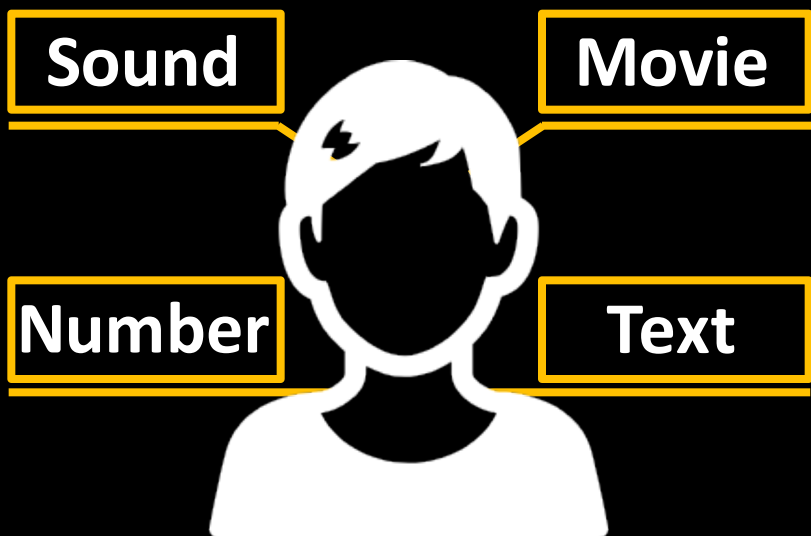
Correct \ Prediction	accident	near miss	non near miss
accident	41.7%	36.1%	22.2%
near miss	17.6%	73.0%	9.5%
non near miss	8.2%	8.2%	83.6%

Movie＋ Sensor(speed＋Acceleration) ＋sound

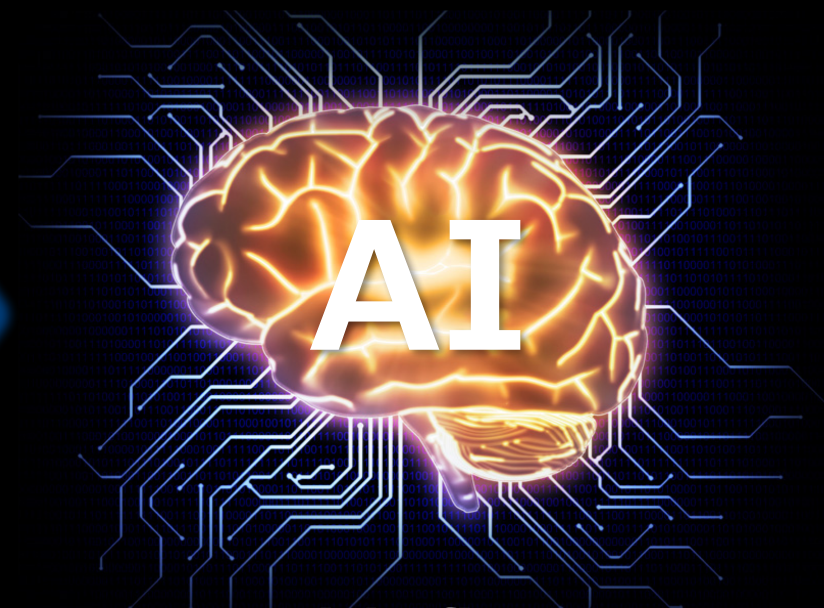
Correct \ Prediction	accident	near miss	non near miss
accident	88.9%	11.1%	0.0%
near miss	4.1%	83.8%	12.2%
non near miss	1.6%	14.8%	83.6%

Comparison of Recall rate

Data Analysis using multimodal Deep Learning



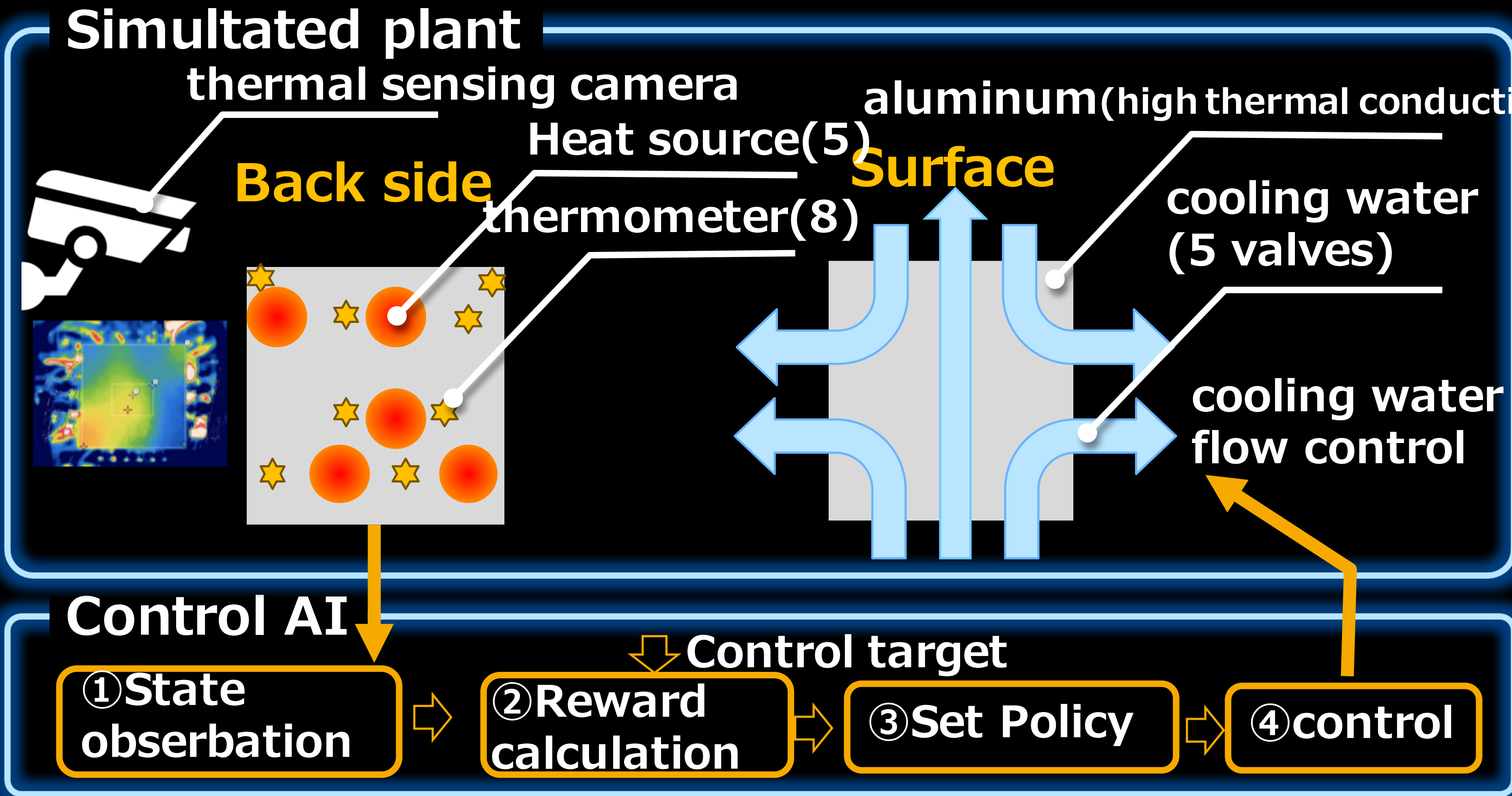
Advanced recognition
by using five senses



AI with five senses

Possibility of solving various problems that were difficult to solve with existing technologies in the other industries

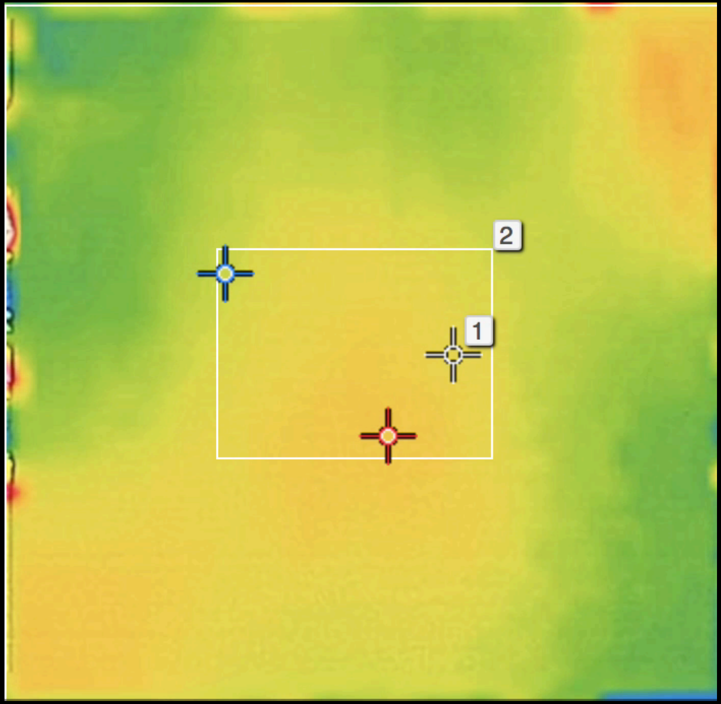
Demonstration of optimal plant control using deep reinforcement learning



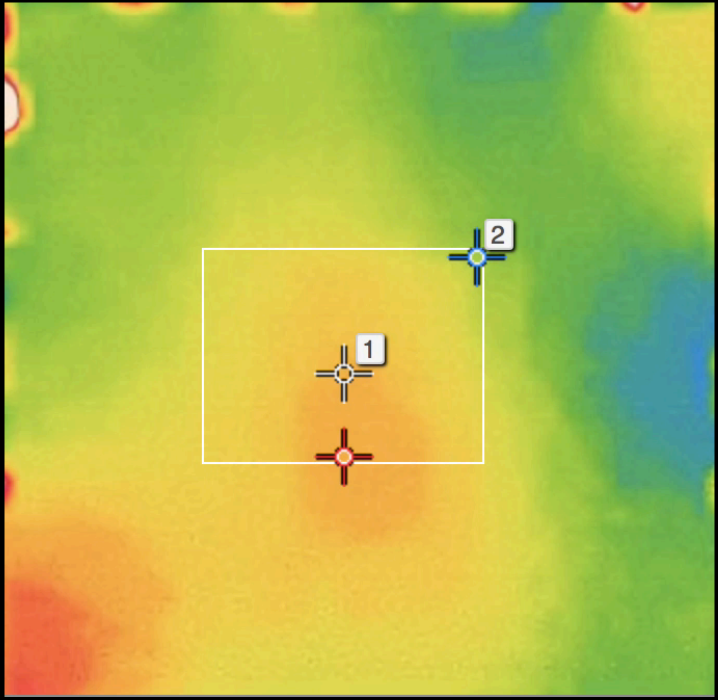
Development of AI that can be applied even in cases where the conventional technology is difficult to control, where multiple heat sources and cooling devices interfere with each other

Demonstration of optimal plant control using deep reinforcement learning

Rule based control



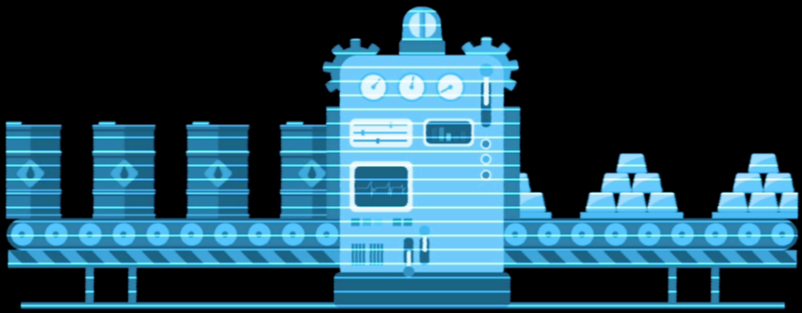
AI based control



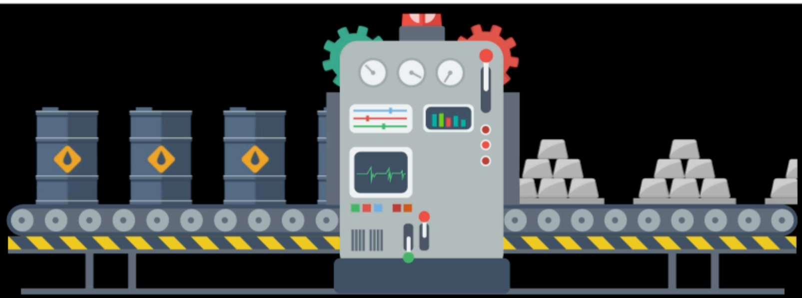
Demo plant

Control monitor

The Future of Digital Twin Manufacturing



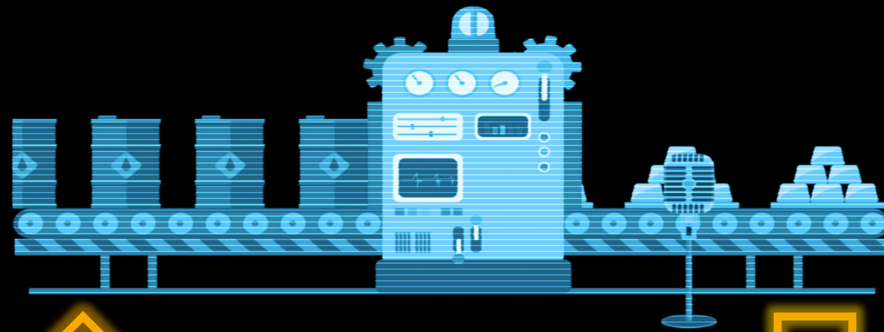
過去のデータから
仮想の工場を**モデル化**



The Future of Digital Twin Manufacturing

②Model accurately and in detail

Digital Twin



Node-AI

①Collect data safely

Real Plant

③Utilization

- Predict
- Control
- Anomaly Detection

Working with customers to innovate and create new businesses through leading-edge services and technologies ranging from networking to AI

Thank you so much