How Hitachi is Using AI in its Social Innovation Business

While AI is a powerful tool for Hitachi's Social Innovation Business, it also by its very nature demands careful consideration of safety, fairness, transparency, and ethics. Hitachi sees an important part of its mission as being to take account of these factors in the practical application of AI as its leads the transition to Society 5.0. Moreover, Hitachi is seeking to achieve this by engaging in collaborative creation with customers in its Social Innovation Business, with Lumada playing a central role. This article uses example applications of AI that embody the thinking behind Hitachi's Social Innovation Business and its collaborative creation with customers to describe the ethical considerations that arise when AI is deployed in society, and how it goes about addressing these.

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1. Introduction

In its the Fifth Science and Technology Basic Plan, Japan's Cabinet Office defines Society 5.0 as "A human-centered society that balances economic advancement with the resolution of social problems by a system that highly integrates cyberspace and physical space." It proposes a vision for the future of society in Japan where the latest technology is put to work to overcome today's challenges. Based on the Society 5.0 concept, Hitachi is seeking to become a global leader in its Social Innovation Business, prioritizing social, environmental, and economic value in the management of its operations. Especially in its five key business sectors of Mobility, Smart Life, Industry, Energy, and IT, Hitachi is forging ahead with its Social Innovation Business as it strives to enhance people's quality of life (QoL) and to create value through the resolution of societal challenges, with a particular focus on the environment, resilience, and safety and security.

This Social Innovation Business is centered around digital technology and collaborative creation in particular. This includes leveraging big data analytics and artificial intelligence (AI) to overcome challenges, consolidating digital technologies on Hitachi Lumada's Digital Innovation Platform. The name "Lumada" derives from the words "illuminate" and "data," expressing the idea of generating value by shining light on data. This use of digital technology to resolve challenges is achieved through collaborative creation with customers and other partners.

Collaborative creation utilizes Hitachi's NEXPERIENCE methodology, which formalizes its collaborative creation practices, together with its experience and technical capabilities drawn from a wide range of business sectors. The value creation process involves reaching a common vision and understanding of the issues being addressed, testing value hypotheses, trialing practical deployment, and commercialization. To engage in collaborative creation globally, Hitachi is also partnering with universities and international agencies around the world to build an ecosystem for resolving challenges. This involves promoting consensus-building by working with stakeholders to formulate visions for how to resolve the challenges facing different communities, with examples including work on formulating scenarios for carbon neutrality with Hitachi-UTokyo Laboratory and on creating a vision for energy, mobility, and healthy cities with Tsinghua University.

While the societal implementation of AI plays a key part in the operation of Hitachi's Social Innovation Business, consideration of ethical issues such as safety and fairness is also essential.

This article presents example applications of AI from Hitachi's Social Innovation Business, also describing how this work takes account of ethical considerations.

2. Deployment of AI in Social Innovation Business

Social Innovation Business requires knowledge of both the digital and real world together with the ability to combine these different forms of expertise to deliver innovation. The platforms for achieving this are provided by Lumada. The term "cyber-physical system" (CPS) is used for such systems that integrate the real world with digital technology. A feature of the CPSs in Hitachi's Lumada is how they use Hitachi's accumulated expertise and experience in operational technology (OT), IT, and products as a basis for the ongoing creation of knowledge on how to use data to change the real world.

AI and other digital technologies play a key role in CPSs, and as AI becomes more deeply entwined in society, people are also starting to get a strong sense of how important it is to address the ethical risks that come with the technology. To deploy and operate AI in ways that are trusted by the public, Hitachi has identified seven items in particular that need to be addressed across the planning, societal implementation, and maintenance and management phases of AI. These are safety, privacy, fairness, proper and responsible development and use, transparency and accountability, security, and legal compliance. This is laid out in the AI Ethical Principles published by Hitachi in February 2021. Underpinning the formulation of these guiding principles are Hitachi's philosophy of coexistence between enterprises and society and its corporate mission of contributing to society through the development of superior, original technology and products, both of which date back to Hitachi's founding in 1910.

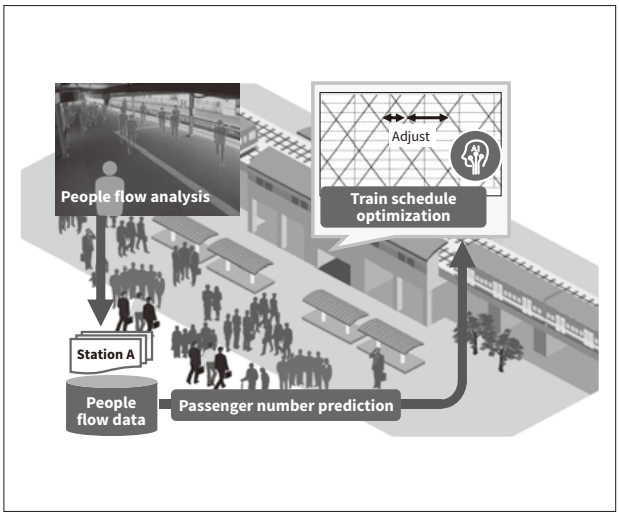
By deploying AI in accordance with its corporate mission and guiding principles, Hitachi intends to build its Social Innovation Business in such a way that AI trusted by the public is able to deliver value through the resolution of many of the challenges facing society.

3. Example Applications of AI

In initiatives spanning a range of different business sectors, Hitachi is using collaborative creation with customers to bring new technologies into widespread use, and in doing so accelerate the progress of its Social Innovation Business. As ethical considerations are essential to the practical application of AI, Hitachi is proceeding with such deployments in a way that considers the particular ethical factors that are most relevant to the project concerned. This section describes example applications of AI in the mobility, smart life, IT, and industry sectors.

Figure 1 — Flow Chart of Dynamic Headway Data Analysis

Demand is determined from data collected from sensors in railway stations and trains and the results are used to optimize the interval between trains (headway) in response to fluctuating demand.



3. 1 Dynamic Headway

Dynamic headway is a world-first solution that delivers new value from railways by having their schedules respond flexibly to changing passenger demand. The solution determines the level of demand using data collected from sensors in railway stations and trains and uses the results to optimize the interval between trains (headway) in response to fluctuating demand (see **Figure 1**).

Passengers benefit from comfortable transportation with less crowding and railway operators benefit from greater operational efficiency. In doing so, dynamic headway provides a mobility system that is conscious of the environment, achieving an optimal balance between the allocation of mobility resources and fluctuations in demand. The technology has been trialed on the Copenhagen Metro where it demonstrated its ability to predict future demand from current levels of crowding with high accuracy. The benefits of dynamic headway have also been verified in simulations.

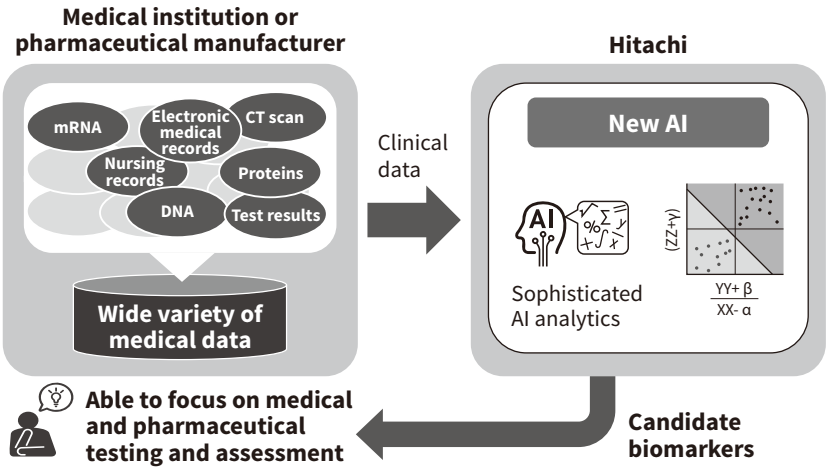
Although the solution uses sensor data to estimate the flow of people, it does not do so in a way that includes the tracking or identification of individuals. The implementation also takes account of privacy, with icons being substituted for images of people when displaying the level of crowding at a railway station to users or station staff.

3. 2 Hitachi Digital Solution for Pharma

The Hitachi Digital Solution for Pharma/Biomarker Discovery Service commenced operation in October 2019. Developed by Hitachi, the service uses AI to find biomarkers that are able to predict treatment efficacy with high accuracy. The AI uses patient data from trials or other clinical use to identify which factors are important to treatment

Figure 2 — AI Used in Hitachi Digital Solution for Pharma/Biomarker Discovery Service

The solution uses AI to identify the most important factors affecting the efficacy of medication and then automatically generates indicators (biomarkers) that can quantify treatment efficacy based on the combination of factors identified.



mRNA: messenger ribonucleic acid CT: computed tomography DNA: deoxyribonucleic acid AI: artificial intelligence

efficacy and side effect prediction. It then uses these to automatically generate indicators that are able to accurately predict treatment efficacy in the form of formulas that are easy for humans to understand (see **Figure 2**).

The service won a Good Design Award in October 2020 that recognized the clarity and transparency of its automatically generated indicators. It is already in use at a number of pharmaceutical manufacturers and research institutions where it is contributing to the discovery of new biomarkers. Rather than the hypothesis-driven approach to biomarker discovery used in the past, use of the service enables a data-driven approach that is free of human cognitive bias and has the potential to discover new biomarker candidates that have previously been difficult to identify. Through use of these biomarkers to predict how individual patients will respond to treatment, the service is also part of the transition to personalized healthcare (where therapies are tailored to the particular requirements of individual patients).

Consideration of AI ethics and bioethics is essential in the research and development of technologies like this. In the case of AI ethics, allowance is made for ensuring that the clinicians who use biomarkers for diagnostic purposes are able to assess their results in the light of their own judgment before reaching a final conclusion, which is done by providing a high level of clarity and transparency to prevent the process of deducing or assigning meanings to biomarkers from becoming a black box. In the case of bioethics, medical research and development work does not commence until it has been approved by the ethical review board of the medical institution involved to ensure that it conforms with national laws and ethical guidelines as well as international ethical principles (the Declaration of Helsinki). Hitachi pays close attention to ethical considerations and always treats patient welfare and benefit as the top priority in its research and development work.

3. 3
Policy Proposal AI

Hitachi Kyoto University Laboratory, established in partnership with Kyoto University, has developed a policy proposal AI.

How to improve sustainability has become a major issue for Japan, where changes in the industrial structure together with its aging population and low birthrate have brought a paradigm shift, leaving the growth and expansion of the past behind to enter a post-growth era.

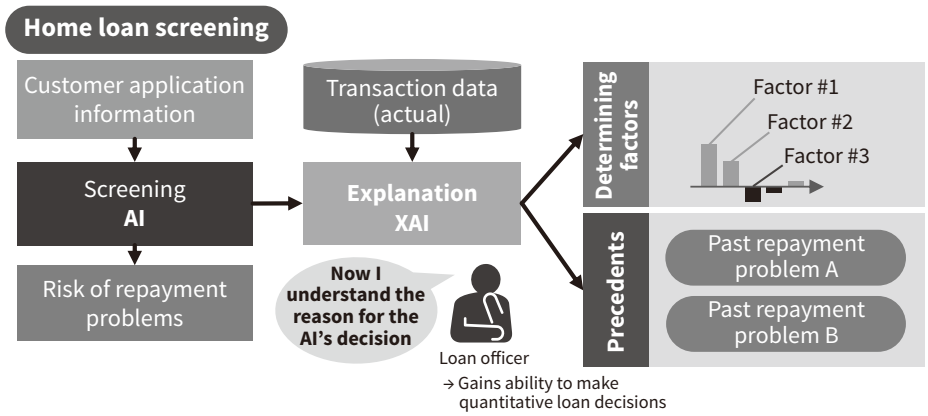
The policy proposal AI is able to create a diagram of how different future scenarios derived from social models branch off from one another, and the factors that determine the branchings. The results of a joint analysis that also involved experts suggest two such scenarios for Japan's future, namely an urban-centric society or a regionally distributed one, with the two scenarios splitting off from one another between 2026 and 2028.

The policy proposal process can be divided into: (1) an information gathering stage for identifying the problems to be solved, collecting relevant information, and then organizing that information into a cause-and-effect model; (2) an options consideration stage in which AI simulations are run using the cause-and-effect model; and (3) a strategy selection stage in which the resulting scenarios are assessed by comparing how well they stack up against the sort of society that people want.

The process developed by Hitachi uses humans to perform stages (1) and (3) and AI to perform stage (2). One ethical factor that should be considered is the potential for

Figure 3 — Home Loan Screening Service Using AI

By using an AI screening model to calculate each loan's probability of default, the service can help reduce the cost of credit and shorten the screening time, both of which have been challenges in the past.



XAI: explainable AI

the dataset used by the human participants to create the cause-and-effect model in stage (1) to contain regional, racial, job-related, or other biases. If so, the future scenarios generated by the stage (2) simulations may describe societies that ignore or disadvantage particular groups. Along with paying close attention to how data is selected to avoid such bias in the input data, the process also seeks to prevent this from happening by having people check whether scenarios include any such inequities during the final strategy selection stage.

3. 4
Home Loan Screening

Dayta Consulting Co., Ltd., a company jointly owned by Hitachi and SBI Sumishin Net Bank, Ltd., has launched an AI loan screening service that combines Hitachi AI with data handling technology and know-how from SBI Sumishin Net Bank (see **Figure 3**).

Home loans involve large amounts of money loaned over long terms. Given that lenders suffer considerable losses when a loan defaults, financial institutions put a lot of time into carefully assessing the likelihood of non-payment based on the applicant's income and the property concerned.

By using an AI screening model to calculate each loan's probability of default, the service can help reduce the cost of credit and shorten the screening time, both of which have been challenges in the past. This is done using Hitachi AI Technology/Prediction of Rare Case (AT/PRC), which is able to demonstrate sufficient accuracy to be used for the final assessment as well as pre-screening.

Deep learning has become a widely used form of machine learning in recent times. Unfortunately, among the challenges that arise in development are the overfitting of models and their tendency to behave like a black box. Overfitting refers to how deep learning can be affected by noise in cases where only a limited amount of data is available, whereas the black box problem is the difficulty of explaining the reasons behind a model's predictions due to the complexity of the mathematical formulas involved. To overcome these challenges, Hitachi used its proprietary signal- and noise-based learning technique to minimize overfitting and explainable AI (XAI) to make the reasons behind the prediction easier to understand, using a technique for calculating degrees of influence to quantify how much each factor influences the result.

The ability to provide explanations was particularly important in the development of this AI service, especially of how the AI calculates a loan's probability of default. Accordingly, a service model was developed that could provide explanations for its loan assessments by using XAI to determine the degree of influence for each of the factors considered, such as the applicant's income and employment details.

3. 5
Manufacturing Automation

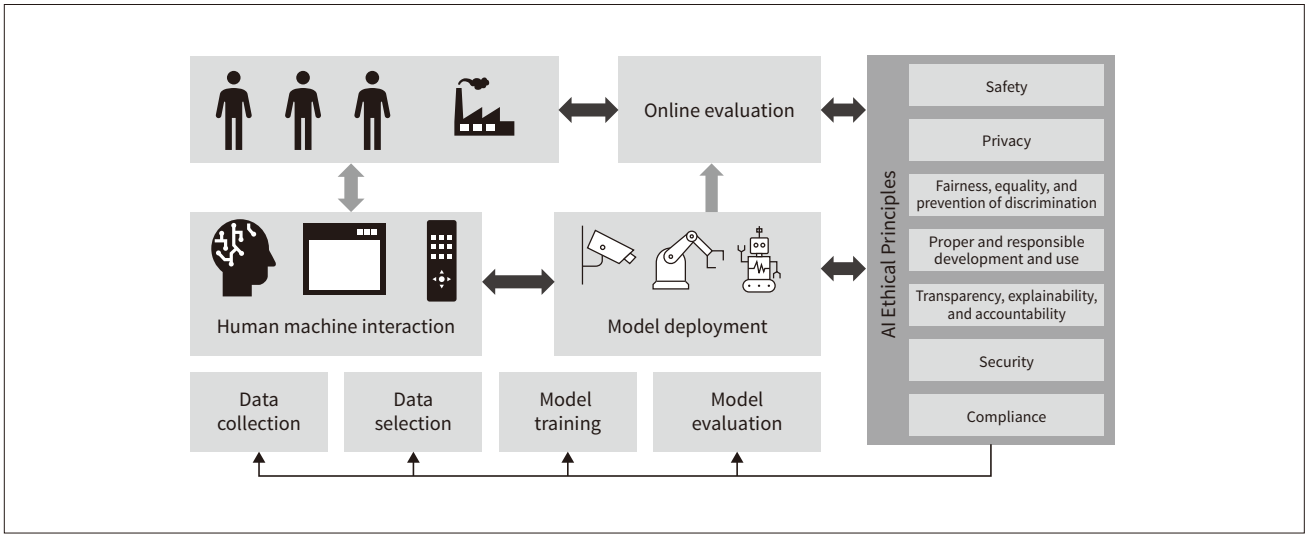
With the aims of automatization and digitalization in the manufacturing industry, Industrie 4.0 is leading digital transformation (DX) and standardization of core manufacturing systems, including assembly-line monitoring systems (see **Figure 4**).

The main goal of such systems is the efficiency and safety of the human operator working alongside collaborative robots (cobots) and other robotic equipment. A fusion of monitoring data from visual and wearable sensors is used for safety and training purposes. Hitachi America, Ltd. is among those developing AI for use with such industrial systems.

AI ethics concerns should be carefully addressed in these environments. First, camera-based and sensor-based monitoring should be restricted to efficiency and safety goals, without intruding on privacy. Second, automated controls

Figure 4 — Example of DX for Core Manufacturing Systems

Monitoring data from vision sensors and wearable sensors is used to improve worker safety and training, while respecting privacy.



should be designed in a way that allows for intervention by skilled staff, with the handoff of control from robots to humans timed to maximize the safety of workers. Finally, the training data, model outputs, and AI models should be constantly checked for bias as well as for any dangerous or repetitive patterns that result in unsafe or/and unfair conditions. Hitachi America is developing ways of addressing these AI ethics concerns, including respect for worker privacy and the establishment of policies and regulations that limit real-time data usage. Furthermore, as wearable sensors may reveal personal health data about workers, it must be non-intrusive, private, secure, and anonymized.

3. 6
Curbside Management

Growth in mobility sharing services combined with rising demand for delivery services, as exemplified by the rapid expansion in e-commerce, is putting increased pressure on transportation in terms of both higher absolute demand and greater demand variability. With this has come a growing need for curbside management, meaning the ability to change how land is used, as needed, such as stretches of road that carry traffic during times of high demand but can be repurposed for car parking or as an event space when demand is low.

With curbside management, connected systems are able to monitor and manage infrastructure components such as Wi-Fi* hotspots, buses, taxis, electric vehicle charging facilities, parking, and bike lanes. Hitachi America has embarked on the development of curbside management systems that collate infrastructure data to predict demand and dynamically assign services in an optimal manner, also providing real-time information about what is happening on the street to both users and administrators.

The use of cameras to monitor people's curbside activity raises privacy concerns. Combining facial recognition with the surveillance of people's behavior patterns, for example, is likely to raise apprehensions among users due to its potential use to identify the routine behaviors of particular individuals. Likewise, optimizing the provision of services solely for revenue may compromise user comfort and service quality.

To overcome these issues, ethical concerns such as fairness, privacy, and security are addressed from the system design stage. Systems should also be designed in such a way that the allocation of resource takes account not only of revenue, comfort, and efficiency, but also fairness and privacy.

4. Conclusions

Recent advances in AI have made possible the use of inductive methods to identify patterns or optimal solutions in large and complex datasets that are difficult for humans to handle, thereby enabling solutions to be found to challenges that are not amenable to human-based deductive methods. On the other hand, it has also brought a number of problems, including how a lack of balance in data (analogous to unconscious bias in humans) can result in inequitable outcomes among AI users, not to mention privacy issues in data collection and the use of data for other than its intended purpose.

Through its Social Innovation Business, Hitachi is helping to bring about Society 5.0 and the Fourth Industrial Revolution, and in doing so is also engaged in research and development to address the ethical problems that arise from this work so as to continue pursuing improvements in people's QoL.

* Wi-Fi is a trademark or a registered trademark of the Wi-Fi Alliance.

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