Chapter 2 — AI R&D in Japan

In response to the rapid progress of AI technology in recent years as described in the previous chapter and international discussions, the newly established "AI Strategic Council" compiled the "Tentative Summary of AI Issues"[1] in May 2023. As described in the Summary, the government will promote initiatives toward responding to international discussions and diverse risks relating to AI, making optimal use of AI, strengthening AI development capabilities, etc.

In addition, research institutions, universities, business enterprises, etc. are advancing various R&D and initiatives for social implementation relating to AI, and R&D expenditures in this field are also on an increase (Figure 1-2-1).

This chapter looks back at notable developments of AI R&D in Japan to date, and introduces the major initiatives since the third AI boom.

■ Figure 1-2-1/R&D expenditures by research sector in the AI field
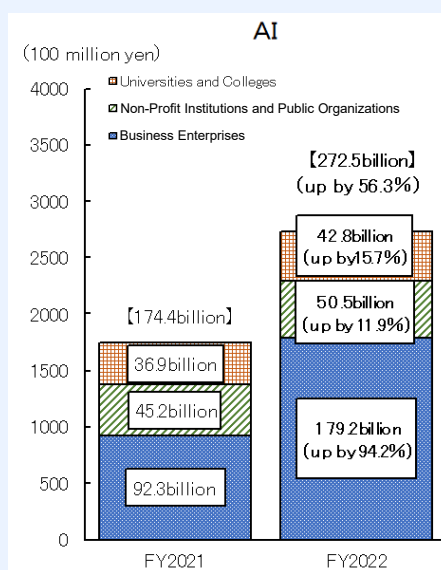
Source: Statistics Bureau, MIC, "2023 Results of the Survey of Research and Development."[2]

Section 1 — History of AI R&D and recent initiatives in Japan

Japanese researchers have also contributed to the

progress of AI technology since the stage of the first

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[1]   AI Strategic Council (2023), "Tentative Summary of AI Issues." https://www8.cao.go.jp/cstp/ai/ai_senryaku/2kai/ronten.pdf

[2]   Statistics Bureau, MIC, "2023 Results of the Survey of Research and Development."
https://www.stat.go.jp/data/kagaku/kekka/kekkagai/pdf/2023ke_gai.pdf

AI boom. AI research spread in Japanese universities as well, with R&D on natural language processing, voice recognition, image processing, etc. starting in around 1960, and full-fledged research on Japanese language information processing starting in the 1970s.

Then, through the "Fifth Generation Computer Project" which was launched by the Ministry of International Trade and Industry at the time as a large-scale project in 1982, the second AI boom arrived, and a large number of human resources were fostered in universities and private companies. However, the limits of practical application were recognized, and the boom ended.

Subsequently, in response to technological progress including the development of deep learning from the 2010s, attention was once again attracted to the potential use of AI, and the "Artificial Intelligence Technology Strategy" was compiled in March 2017, the "Social Principles of Human-Centric AI" in March 2019, and the "AI Strategy 2022" in April 2022. Based on these strategies, etc., MIC, MEXT, METI, and other ministries and agencies concerned and national research and development agencies, etc. promoted R&D and initiatives for social implementation of AI technology in collaboration with each other. In addition, private companies and startup companies also advanced R&D. Major initiatives are described below.

- Establishment of the Artificial Intelligence Research Center[1] (AIRC), National Institute of Advanced Industrial Science and Technology (AIST)

Since its establishment in May 2015, AIRC has made numerous achievements in R&D on element functions of AI. It has built and published software modules implemented in easy-to-use programs, and has been pioneering applied technologies in a wide variety of fields including "productivity improvement," "health, medical care, and welfare," and "mobility." With focus on further fundamental technologies that are necessary for embedding AI in the real world, AIRC promotes R&D for linking fundamental research to social implementation under the three pillars—AI that can cooperate with humans, AI that can be trusted in the real world, and AI that can be built easily.

- Establishment of the RIKEN Center for Advanced Intelligence Project (AIP Center)[2]

The AIP Center, established in April 2016, brings together the world's cutting-edge researchers, and promotes R&D of innovative fundamental technologies and R&D using big data, which is Japan's strong point. With regard to research of fundamental general-purpose technologies, the AIP Center aims to elucidate the principles of deep learning, and realize fundamental technologies that can be applied to complicated and imperfect advanced data, which cannot be dealt with by the current AI technology. In addition, it aspires to solve social issues by using AI, while extending Japan's strong points with the use of AI. Further, the AIP Center is working to clarify the ethics of the relationship between AI and humans, and to examine legal systems for making the most out of AI.

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1   https://www.airc.aist.go.jp/

2   https://www.riken.jp/research/labs/aip/

● Establishment of the AI Science Research and Development Promotion Center (AIS),[1] National Institute of Information and Communications Technology (NICT)

In April 2017, AIS was established as an open-innovation-type strategic R&D promotion center that develops an R&D environment easily accessible by industry, universities, and the government, including data that has been accumulated by NICT, and that promotes next-generation R&D in the AI science domain.

● Development of a deep learning framework "Chainer" by Preferred Networks, Inc.

Preferred Networks is a startup company established in 2014, which is active at the forefront of AI research. The company developed an original deep learning framework "Chainer," and open-sourced it in June 2015.[2] As Chainer allows the building of complex neural networks in intuitive and flexible ways, it gained wide support from research and development communities, and contributed to the development of technologies relating to deep learning in their early days. Since December 2019, Preferred Networks has participated in the development of "PyTorch" in collaboration with the U.S. company, Meta Platforms Inc., and contributed to the PyTorch ecosystem.[3]

● AI R&D by Toyota Motor Corporation

In January 2016, Toyota Motor Corporation established Toyota Research Institute (TRI), a new company to conduct research and development using the latest AI technology in Silicon Valley, U.S. The mission of TRI is to improve the quality of human life by developing new tools and capabilities to amplify the human experience. To promote innovation in mobility, TRI has formed the world's top-class teams in the fields of robotics, Human-Centered AI, Human Interactive Driving, and Energy & Materials.

● Establishment of the AI Japan R&D Network[4]

With the aim of bringing together Japan's expertise and stimulating AI R&D activities, the AI Japan R&D Network was established in December 2019 under the initiative of AIST, RIKEN, and NICT as a consortium consisting of members from universities, public research institutes, etc. that are actively engaged in AI R&D in Japan, and it promoted collaborations on AI R&D. Then, in April 2023, AI Japan R&D Network was restructured as a voluntary organization, with private companies also joining in as new members, and it has engaged in further collaboration activities for promoting AI R&D and use of the R&D results.

1   https://www2.nict.go.jp/ais/

2   Preferred Networks, Inc., "Deep Learning Frameworks." https://www.preferred.jp/ja/projects/dlf/
3   Preferred Networks, Inc., "Preferred Networks Migrates its Deep Learning Research Platform to PyTorch."
     https://www.preferred.jp/ja/news/pr20191205/
4   AI Japan R&D Network. https://www.ai-japan.go.jp/

| Column 1-2 | Views on the AI Boom and the Future from the Forefront of AI Research |

● OKANOHARA Daisuke

Representative Director & Chief Executive Researcher, Preferred Networks, Inc.

We interviewed Mr. OKANOHARA, Representative Director of Preferred Networks, Inc., who is at the forefront of AI research.

As to what "AI" is, there is no clear definition of the term in the world, with at least 60 to 70 definitions given by renowned researchers alone, and this is a common understanding worldwide.

The current AI boom is undoubtedly driven by the release of ChatGPT in November 2022. Unlike the conventional AI that was mostly designed for specific tasks, such foundation model could be used for various purposes, and was easily accessible for ordinary people who were not necessarily AI experts. Therefore, the number of users grew dramatically. The AI market will continue to expand in the future.

On the other hand, there have been repeated cycles of excessive expectations and disillusionment with AI in the past, so there is a possibility that this will happen again. Hallucinations could become a major problem. At the present point, it can be said that we humans ultimately need to keep watch of areas where the impact will be critical.

As a future AI development strategy, I believe that Japan can gain competitiveness by specializing and segmentalizing general-purpose foundation models to fields that require field-specific knowledge. Particularly compatible areas are areas that require knowledge of fields such as material discovery, life science, weather, and space. Other compatible areas are mathematics and computer programs, and I think these fields are on the verge of breakthroughs.

AI is likely to affect science and R&D in the same way as how the emergence of computers has changed the way research is conducted. For example, it may become possible to discover symmetries or patterns that humans cannot find in research.

I think there are often cases where AI research does not go well, and researchers become subject to finger-pointing. They may also be criticized when conducting research on something that actually did not work in the past. However, as the performance of AI is improving at an exponential rate, it might work if we try now. I hope Japan will be an environment where we can conduct research "without reading the situation" so to speak.

Section 2   R&D on generative AI in Japan

While development of OpenAI's ChatGPT and other large language models makes progress around the world, there are issues such as a lack of models with a high ability to handle Japanese language[1] and concerns about monopolization by some companies. In light of such a situation, Japanese universities, national research and development agencies, and companies, etc. are also rapidly developing generative AI such as Japanese large language models and lightweight models with high Japanese processing capabilities that are assumed to be used in people's daily lives and in industrial settings as well.

One of the pioneering initiatives in developing large language models specializing in Japanese language is the development of "ELYZA Brain" in 2020 by ELYZA, Inc., a startup originating from the University of Tokyo. Then in August 2021, ELYZA, Inc. released "ELYZA Digest," a "generative" summarization model which digests input text data into three lines,[2] and further, in

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[1]   The percentage of Japanese language data in GPT-3 is 0.11%.
       Reference: https://github.com/openai/gpt-3/blob/master/dataset_statistics/languages_by_word_count.csv
[2]   ELYZA, Inc., "'ELYZA DIGEST.' a summarization AI that can digest any sentences into three lines, used by 130,000 users in five days after the release."
       https://prtimes.jp/main/html/rd/p/000000012.000047565.html

March 2022, it released "ELYZA Pencil," a large language model which can generate Japanese sentences from keywords in about 6 seconds. [1] Moreover, in March 2024, the company announced that it developed "ELYZA-japanese-Llama-2-70b," a Japanese large language model with 70 billion parameters (70B), achieving a performance comparable to global models. [2]

Meanwhile, in December 2023, a research team led by Professor Naoaki OKAZAKI and Professor Rio YOKOTA from Department of Computer Science, School of Computing, Tokyo Institute of Technology, and AIST rolled out "Swallow," a series of large language models which are generative AI foundation models with high Japanese language capabilities. [3] It was developed by enhancing the Japanese capability of U.S. Meta's Llama 2, an open-source large language model with high capabilities in English language understanding and conversational skills. At present, models with 7 billion parameters (7B), 13 billion parameters (13B), and 70 billion parameters (70B) are available. These models are open and can also be used for commercial purposes. [4]

Furthermore, the "LLM-jp" [5] launched by the National Institute of Informatics (NII), Research Organization of Information and Systems (ROIS), in May 2023 aims to develop the world's top-level large language models (LLMs) that are open and have high Japanese language proficiency. As the first step, it successfully built and released an LLM with 13 billion parameters (13B) in October 2023.

At present, it is working to build an LLM with 175 billion parameters.

Various efforts are also being made at private companies. For example, NEC Corporation (NEC) developed "cotomi," a lightweight LLM with high Japanese language proficiency with 13 billion parameters, and made it available for commercial use in August 2023. [6] The company is also developing small-scale to large-scale (a 100 billion parameter class) LLMs.

SoftBank Corp. developed a computing infrastructure for generative AI development (see Section 3), and its subsidiary company, SB Intuitions Corp. has started developing a Japanese-based homegrown LLM by utilizing this computing infrastructure. SB Institutions Corp. aims to build a homegrown LLM with 390 billion parameters within FY2024. [7]

Nippon Telegraph and Telephone Corporation (NTT) developed "tsuzumi," a lightweight LLM with Japanese language proficiency. It is available in two versions: a "lightweight version" with a parameter size (representing the scale of parameters used in training) of 7 billion and an "ultra-lightweight version" with a parameter size of 600 million, [8] and announced its commercialization in March 2024. [9] tsuzumi also has a multimodal function to read not only text, but also the contents of diagrams, tables, and graphs contained in the document to provide a response. tsuzumi is also planned to support modal extension

1   ELYZA, Inc., "First of its kind in Japan. 'ELYZA Pencil,' Japanese text-writing AI which can generate sentences from keywords in about 6 seconds released to the public." https://prtimes.jp/main/html/rd/p/000000015.000047565.html
     *The trial versions of "ELYZA Digest" and "ELYZA Pencil" mentioned above have ended their services, and similar functions can be used in the demo version of "ELYZA LLM for JP."
2   ELYZA, Inc., "ELYZA develops a Japanese LLM comparable to global models. Demo version released."
     https://prtimes.jp/main/html/rd/p/000000042.000047565.html
3   TokyoTech-LLM, "Swallow." https://tokyotech-llm.github.io/swallow-llama
4   AIST, "'Swallow,' a series of large language models with high Japanese language proficiency, released."
     https://www.aist.go.jp/aist_j/press_release/pr2023/pr20231219/pr20231219.html
5   https://llm-jp.nii.ac.jp/
6   NEC Corporation, "NEC develops and starts provision of generic AI for the Japanese market: launching a customer program aimed at building industry-specific knowledge."
     https://jpn.nec.com/press/202307/20230706_01.html
7   SoftBank Corp. "Earnings Results Briefing for Q3 FY2024."
     https://www.softbank.jp/corp/set/data/ir/documents/presentations/fy2023/results/pdf/sbkk_earnings_presentation_20240207.pdf
8   NTT, "NTT starts provision of a commercial service using its proprietary large language model, 'tsuzumi,' in March 2024."
     https://group.ntt/jp/newsrelease/2023/11/01/pdf/231101aa.pdf
9   © NTT Communications Corporation, "NTT Communications Corporation starts provision of solutions using NTT's LLM 'tsuzumi': solicitation of partnership programs also starts" https://www.ntt.com/content/dam/nttcom/hq/jp/about-us/press-releases/pdf/2024/0325_2.pdf

to understand not only visual information, but also nuance in voice tones, facial expressions, and the user's given situation. In addition, tsuzumi is being studied to also control physical tasks in collaboration with a robot having physical senses, as one example of its application (Figure 1-2-2).

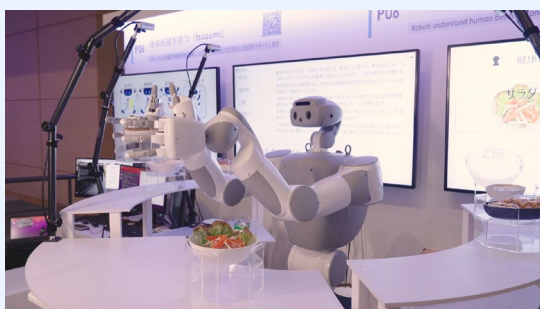■ Figure 1-2-2／tsuzumi collaborating with a robot

Photo courtesy of NTT.

Meanwhile, Sakana AI, an AI startup established by former Google researchers and others in Tokyo in July 2023, announced in March 2024 that, with an aim to apply nature-inspired ideas, such as evolution and collective intelligence, to create new foundation models, it developed "evolutionary model merge," a method that merges existing open-source models to automatically create new, more advanced foundation models.[1]

LLM development is also carried out in major foreign countries, and international competition is accelerating. In such a situation, METI launched the Generative AI Accelerator Challenge (GENIAC),[2] a project to enhance Japan's capability to develop generative AI. Under this project, it will provide support to companies, etc. in securing computing resources for developing foundation models as a core technology of generative AI, encouraging collaboration among stakeholders, conveying related information to overseas countries, and so forth. Under this framework, the New Energy and Industrial Technology Development Organization (NEDO) publicly solicited companies, etc. that develop foundation models that are competitive and have a greater ripple effect for the "Research and Development Project of the Enhanced Infrastructures for Post-5G Information and Communication Systems," and selected the seven corporations, etc. shown in Table 1-2-3 in February 2024.[3] GENIAC started supporting the adopted corporations, etc. in securing computing resources and providing subsidies for the costs incurred in the use of these resources. GENIAC also holds various events not only to provide developers with opportunities to widen networks but also to promote the utilization of generative AI, including seminars, networking events for developers, and events to match developers and users.

1　Sakana AI, "Building foundation models by evolutionary algorithms."
　　https://sakana.ai/evolutionary-model-merge-jp/
2　https://www.meti.go.jp/policy/mono_info_service/geniac/index.html
3　METI, "Successful applicants chosen for the 'Research and Development Project of the Enhanced Infrastructures for Post-5G Information and Communication Systems' (February 2, 2024)."
　　https://www.meti.go.jp/policy/mono_info_service/joho/post5g/20240202.html

■ Table 1-2-3/ List of corporations, etc. selected for the "Research and Development Project of the Enhanced Infrastructures for Post-5G Information and Communication Systems"

Player	Outline
ABEJA, Inc.	R&D of a general-purpose LLM that will serve as the basis for specialized models for the social implementation of LLMs
Preferred Elements, Inc.	Construction of large multimodal foundation models with 100B/1T parameters
The University of Tokyo	Development of an open foundation model that aims to improve a variety of Japanese language skills
Sakana AI	Development of models that use important technologies (distillation, mixture of experts (MoE), reinforcement learning) for increasing the efficiency of foundation model development that require a large amount of computing resources
Stockmark Inc.	Development of a foundation model that deters hallucinations, which present concerns and obstacles in actual business use
National Institute of Informatics, ROIS	Construction of an open and Japanese-proficient GPT-3 (175 billion parameters) LLM
Turing Inc.	Developing a multimodal (language and still and moving images) foundation model that is particularly suited to the Japanese traffic environment, in view of achieving fully autonomous driving

Source: Created by MEXT based on METI's "Outline of the Adopted Project Themes."

Section 3	Development and utilization of computing resources and data resources for the development of foundation models

Development of foundation models, such as LLMs, requires large amounts of training data and computing resources, and their costs and environmental burden are considered to be concerns. Therefore, the Japanese government supports the shared use of computing resources between research institutions and industry, as well as initiatives for developing computing resources and improving the environment for their use.

Japanese supercomputers, represented by "Fugaku," are also being used in the development of AI technology and the computation of deep learning as powerful tools for performing complicated simulations and data analyses. With Fugaku, R&D is promoted with priority on using AI and data science. In this way, data analysis and model training of an unprecedented scale are becoming possible through the combination of AI and supercomputers.

In May 2023, Tokyo Institute of Technology, Tohoku University, Fujitsu Limited, and RIKEN embarked on development of a technology to efficiently perform large-scale language model training on a large-scale parallel computing environment by using Fugaku.[1,2] The results of this R&D is scheduled to be published in FY2024, and it is anticipated that their use by many researchers and engineers in Japan will lead to the next generation of innovative research and business results. RIKEN also conducts R&D on collaboration between the first Japanese built superconducting quantum computer "A" and Fugaku.

In April 2024, the Global Scientific Information and Computing Center at Tokyo Institute of Technology started operation of its latest supercomputer "TSUBAME4.0." Equipped with high-performance graphics processing units (GPUs), TSUBAME4.0 has the second highest computing performance among existing supercomputers in Japan, following Fugaku, and is expected to be actively used in a wider range of fields including scientific and technical computing, big data analysis, and AI (Figure 1-2-4).

With regard to the "AI Bridging Cloud

■ Figure 1-2-4/"TSUBAME4.0," the latest supercomputer of the Global Scientific Information and Computing Center, Tokyo Institute of Technology

Photo courtesy of Tokyo Institute of Technology

■ Figure 1-2-5/Appearance of the ABCI

Photo courtesy of AIST

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1   RIKEN, "Development of distributed training of large language models within the scope of the initiatives for use of supercomputer 'Fugaku' defined by Japanese policy."
     https://www.riken.jp/pr/news/2023/20230522_2/index.html
2   CyberAgent, Inc., Nagoya University, and Kotoba Technologies Inc. also joined in the initiative in August 2023.

■ Table 1-2-6／Proposals adopted for the Large-scale Language Model Building Support Program 2023

	Organization	Proposal	Period	Number of nodes
Round 1	Preferred Networks, Inc.	LLM training using large-scale data including Japanese data	August to September	60
Round 2	Representative organization: National Institute of Informatics, ROIS Participating organizations: AIST, Tokyo Institute of Technology, and LLM-jp	Construction of an open and Japanese-proficient GPT-3 (175 billion parameters) LLM and promotion of related R&D	October to November	60
	ELYZA, Inc.	Japanese language training of an open English-based LLM and improvement of its performance	December to January	40

Source: Created by MEXT based on the AIST website data.

Infrastructure (ABCI)"[1] (Figure 1-2-5), which is computing infrastructure for AI processing built and operated by AIST, facilities are promptly being expanded in order to reinforce the fundamental development capabilities related to generative AI. In addition, AIST provided a "Large-scale Language Model Building Support Program"[2] which allows users who wish to build LLMs to reserve and use abundant computing resources with high performance and a maximum of 80 nodes[3] (640 GPUs) for up to 60 days. As shown in Table 1-2-6, initiatives by three organizations were adopted in FY2023, leading to the development of "Swallow" and "ELYZA-japanese-Llama-2-70b," which are LLMs with high Japanese proficiency introduced in Section 2.

Moreover, as cloud services have become indispensable in a wide range of people's lives and industrial activities, there is a need to swiftly secure industrial infrastructure for developing programs to be used for providing basic cloud services (basic cloud programs) in Japan. Accordingly, based on the Act on the Promotion of Ensuring National Security Through Integrated Implementation of Economic Measures, the government designates "cloud programs" as specified critical products of which stable supply should be ensured, approves the plans of business entities that engage in development of important technologies or improvement of the environment for using advanced computers, and subsidizes necessary expenses. To date, the government has approved plans of entities such as the University of Tokyo (provision of cloud services using a quantum computer), SAKURA internet Inc., SoftBank Corp., and Xeureka Inc. (provision of computing resources for basic cloud programs, including generative AI, in the cloud) (Figures 1-2-7 and 1-2-8).[4]

1　https://abci.ai/ja

2　AIST, "Large-scale Language Model Building Support Program." https://abci.ai/ja/link/llm_support_program.html
3　A node is a term meaning a "knot" or "gnarl." In the supercomputer field, a single management unit is often called a node. For example, it refers to a cluster of CPUs and memories on which a single operating system runs.
4　METI, "Ensuring a stable supply of cloud programs." https://www.meti.go.jp/policy/economy/economic_security/cloud/index.html

■ Figure 1-2-7／Facility of SAKURA internet's data center

Photo courtesy of SAKURA internet Inc.

■ Figure 1-2-8／Facility of SoftBank's generative AI computing platform

Photo courtesy of SoftBank Corp.

The development of AI models requires a vast amount of data. Therefore, the Cabinet Office formulated an "Action Plan for Promoting the Provision of AI Training Data ver. 1.0" in November 2023, in order to promote the provision of data owned by the government, etc. as AI training data according to the needs of AI developers.[1]

LLMs such as OpenAI's GPT models train by using information collected from the web, and it is said that the amount of training in Japanese is extremely small compared to that in English. Thus, when developing Japanese LLMs, data on Japan and Japanese language will be required, and development of a database called a "corpus" which has systematically collected written or spoken texts will also be important. So far, the National Institute for Japanese Language and Linguistics of the National Institutes for the Humanities (NIHU) has developed the "Balanced Corpus of Contemporary Written Japanese" containing about 100 million words and the "Corpus of Spontaneous Japanese," but a larger scale of data will be required for building LLMs. In the development of Swallow by Tokyo Institute of Technology and AIST, which was introduced in Section 2, they built a large Japanese web corpus consisting of approximately 312.1 billion characters (approximately 173 million pages) by independently extracting and refining Japanese text from web texts of as many as approximately 63.4 billion pages collected between 2020 and 2023, and used it for the training.[2]

Due to the characteristics of the Japanese language, when developing a Japanese language model, it will also be important to perform language processing, such as dividing words and identifying the part of speech, with high accuracy. In April 2019, Megagon Labs, which is an AI research institution of Recruit Co., Ltd., released "GiNZA,"[3] a Japanese natural language processing (NLP) library that enables engineers and data scientists around the world to seamlessly utilize Japanese NLP technology and that of other languages, by applying the results of joint research

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[1] Secretariat of Science, Technology and Innovation Policy, Cabinet Office (2023), "Action Plan for Promoting the Provision of AI Training Data ver. 1.0." https://www8.cao.go.jp/cstp/ai/ai_senryaku/6kai/2aidata.pdf

[2] TokyoTech-LLM, "Swallow Corpus." https://tokyotech-llm.github.io/swallow-corpus
[3] Megagon Labs, "GiNZA: open-source Japanese natural language processing library." https://megagon.ai/jp/projects/ginza-install-a-japanese-nlp-library-in-one-step/

with the National Institute for Japanese Language and Linguistics of NIHU.[1]

In addition, as a measure to reinforce LLM development capabilities in Japan, MIC will have NICT develop and expand large-amount, high-quality, and safe language data for training, mainly in the Japanese language, and provide these data for Japanese LLM developers, etc., starting in 2024.

| Section 4 | Measures and R&D for ensuring AI safety |

In regard to AI technology, it is important not only to improve the accuracy and performance of the technology, but also to respond to concerns such as the "transparency" of the algorithm based on which the answers are generated and the "reliability" of the correctness of the answers, as well as to ethical, legal and social issues (ELSI).

Deep learning is criticized as being a black box, because its results are weights of links in a multilayered neural network, and it is difficult for humans to intuitively understand their meaning, and also it does not explain the reasons for making such determinations in a way understandable by humans. In other words, the operation cannot be guaranteed, and there is a risk that, in the event of an accident, it may not be possible to identify the cause or determine the responsibility.

It has also been pointed out that LLMs have a problem called "hallucinations," which is a phenomenon where LLMs create information that does not exist as if it actually exists, and the false information that has been generated appears so correct that humans, even experts, cannot determine whether it is real.[2] The goal of machine learning is to achieve "generalization," the ability to acquire laws and rules from training data and respond to unknown cases that are not included in the training data, but if generalization is not performed appropriately, there is a risk of deriving incorrect relationships or information.

Moreover, as a decision made by machine learning reflects the tendency of the training data, a risk has been indicated that, if the training data includes data with values or biases, or if there is a bias in the distribution of data, this may also be reflected in the decision.

Considering this context, the AI Strategic Council indicated the following as specific examples of risks of concern: [i] risk of leakage of confidential information and inappropriate use of personal information; [ii] risk of sophistication and facilitation of crimes; [iii] risk of social instability and confusion due to disinformation, etc.; [iv] risk of more sophisticated cyberattacks; [v] handling of generative AI for education; [vi] risk of copyright infringement; and [vii] risk of increased unemployment due to AI.[3]

Furthermore, the ideal governance of AI is discussed not only in each country, but also multilaterally. In particular, to examine global governance based on the technological progress of generative AI, an in-depth discussion was held at the "Hiroshima AI Process" launched in May 2023, and in December, the outcomes of the discussions, including the "Hiroshima AI Process Comprehensive Policy Framework," were endorsed by the Leaders of the Group of Seven (G7) in a G7 Leaders' Statement (see Chapter 3, Section 2). In addition, as well as the United States and the United Kingdom, Japan also established the "AI Safety Institute"[4] in February 2024 with the objective of developing evaluation methods

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1   Recruit Co., Ltd., "Recruit's AI research institution releases 'GiNZA,' a Japanese natural language processing library using the results of joint research with the National Institute for Japanese Language and Linguistics." https://www.recruit.co.jp/newsroom/2019/0402_18331.html
2   Okanohara, D. (2023) *Daikibo gengo moderu wa aratana chinōka* (Are large language models a new type of intelligence?), Iwanami Library of Science
3   *Supra* AI Strategic Council (2023), "Tentative Summary of AI Issues."
4   https://aisi.go.jp/

and standards for AI safety. Moreover, in April 2024, MIC and METI compiled the "AI Guidelines for Business" for all AI business actors, to promote utilization of AI, while recognizing AI risks.

In response to the distribution and spread of dis-/mis-information on the internet, MIC set up the "Expert Group on How to Ensure Healthy Information Distribution in the Digital Space" in November 2023. The expert group considered comprehensive measures, including responses to risks associated with advances in generative AI and deepfake (DF) technologies, and published a report summarizing the study in the summer of 2024.

Along with such initiatives concerning AI governance, development of technologies that support the securing of the transparency and reliability of AI is also being promoted. For example, it is expected that, by using a technology such as "retrieval-augmented generation (RAG)," which combines external information retrieval with LLMs, the basis for the output results will become clear and generation of information that is not based on facts can be suppressed. Meanwhile, the National Institute of Informatics, ROIS, developed techniques for effectively and efficiently mitigating risks by misperception of image recognition AI, in collaboration with Kyushu University.[1] In April 2024, the "Research and Development Center for Large Language Models" will be established in NII to conduct R&D for securing the transparency and reliability of generative AI.

In addition, as ethical concerns have been pointed out about privacy and use of data with regard to a case where the training data for AI contains personal information, technologies that enable data analysis while enhancing and protecting privacy are being developed. Specifically, universities and companies, etc. are conducting research and development on technologies such as data anonymization technology for protecting the data to be analyzed, differential privacy technologies for protecting database query results, and secure computation technologies for protecting the content of data during the computation process, etc. For example, a secure computation technology developed by Nippon Telegraph and Telephone Corporation (NTT) was adopted[2] as an international standard by the International Standardization Organization (ISO) in March 2024. The application of these technologies in the field of AI is making progress.

Furthermore, toward the establishment of secure AI systems, the Secretariat of Science, Technology and Innovation Policy, Cabinet Office and the National center of Incident readiness and Strategy for Cybersecurity co-sealed the "Guidelines for secure AI system development" which the UK National Cyber Security Centre jointly developed with the U.S. Cybersecurity and Infrastructure Security Agency, etc., in November 2023. They also co-sealed and published the international guidance for organizations engaging with AI "Engaging with Artificial Intelligence," which the Australian Cyber Security Centre jointly developed with the relevant authorities of New Zealand, the United Kingdom, and the United States, in January 2024.[3,4]

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1   National Institute of Informatics, ROIS, "Techniques for Effectively and Efficiently Mitigating Risks by Misperception of Image Recognition AI:-- Evaluated in Safety Benchmark for Automated Driving Systems --" https://www.nii.ac.jp/news/release/2023/0317.html

2   NTT, "NTT's Secure Computing Technology adopted as ISO International Standard: Secure computing technology to speed up data utilization and protect privacy." https://group.ntt/jp/newsrelease/2024/03/21/240321b.html

3   Cabinet Office (2023) "Regarding Guidelines for secure AI system development" https://www8.cao.go.jp/cstp/stmain/20231128ai.html

4   Cabinet Office (2024) "Regarding co-sealing of the international guidance for organizations engaging with AI." https://www8.cao.go.jp/cstp/stmain/20240124.html

In addition, in the "Key and Advanced Technology R&D through Cross Community Collaboration Program"[1] which is implemented across ministries and agencies under the framework of the Council for the Promotion of Economic Security and the Integrated Innovation Strategy Promotion Council, and with the initiative of the Cabinet Office, MEXT, and METI, "establishment of AI security technology necessary for data-driven economy and society in which artificial intelligence (AI) is pervasive" was also indicated as one of the R&D Concepts, and relevant R&D themes were publicly solicited in FY2023.

Section 5	Development of AI human resources

Initiatives are also in progress to develop human resources having cutting-edge AI knowledge and skills. In order to promote human resource development in the AI field and emerging/fusional areas of the AI field (the next-generation AI field) and cutting-edge research and development in the field, MEXT launched "Broadening Opportunities for Outstanding young researchers and doctoral students (BOOST): Next Generation AI Human Resource Development Project,"[2] and the Japan Science and Technology Agency (JST) started the public solicitation of doctoral students in January 2024. The project aims to increase the number of researchers in the national strategic area and thereby strengthen the creation of innovation and industrial competitiveness by providing doctoral students intending to engage in R&D that contributes to the next-generation AI field with sufficient funds as an amount equivalent to living expenses and research funds.

Moreover, METI promotes an initiative called "MITOU Program" to discover and develop outstanding individuals that possess the creative ideas and skills needed for innovation in not only in AI, but in IT, as well as the ability to utilize and realize them (Table 1-2-9).

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1   Cabinet Office, "Key and Advanced Technology R&D through Cross Community Collaboration Program."
https://www8.cao.go.jp/cstp/anzen_anshin/kprogram.html

2   JST, "Broadening Opportunities for Outstanding young researchers and doctoral students (BOOST): Next Generation AI Human Resource Development Project." https://www.jst.go.jp/jisedai/boost-s/index.html

■ Table 1-2-9/Examples of AI human resource development programs

Program	Target	Outline
Approved Program for Mathematics, Data Science and Smart Higher AI Education (MEXT)	Universities and colleges of technology	The Minister of Education, Culture, Sports, Science and Technology certifies, selects, and encourages programs that provide systematic education on knowledge and technologies related to mathematics, data science, and AI. The total number of certified education programs were 382 for the literacy level and 147 for the advanced literacy level as of August 2023.
K-DASH (KOSEN Mathematics, Data science and AI Smart Higher Educational Community)[1] (MEXT and the National Institute of Technology)	Colleges of technology	Asahikawa College and Toyama College, as base schools, implement mathematics, data science, and AI education in collaboration with other colleges of technology (KOSEN) nationwide. They indicate "KOSEN students who accelerate their skills with AI and DS (data science)" and "KOSEN students who accelerate their skills to become specialists with AI and data" as human resources that should be developed at colleges of technology nationwide. They aim to have 100% of their graduates acquire the literacy level skills and 20% or more acquire the advanced level, and produce talents such as researchers and entrepreneurs from the top 1%.
Broadening Opportunities for Outstanding young researchers and doctoral students (BOOST): Next Generation AI Human Resource Development Project (MEXT and the JST)	Young researchers and doctoral students	Supports young researchers and doctoral students intending to engage in R&D that contributes to the next-generation AI field (the AI field and emerging/fusional areas of the AI field).
ACT-X (MEXT and the JST)	Young researchers who have held a doctoral degree for less than eight years (including graduate school students)	Supports young researchers with unique and challenging ideas. In this program, "Frontier of Mathematics and Information Science," "AI Powered Research Innovation/Creation," and "Innovations in Mathematical and Information Sciences to Build the Next-Generation AI" were established as research areas relating to AI, and support is provided to a total of 187 young researchers as of the end of FY2023 (including completed projects).
MITOU Program (METI and the Information-technology Promotion Agency)	MITOU IT Program: Project for finding and developing undiscovered IT talents: under 25 years of age MITOU Advanced Program: all ages MITOU Target Program: all ages	Implements the following: the "MITOU IT Program: Project for finding and developing undiscovered IT talents," which discovers and develops young individuals with an aim to discover and develop outstanding individuals that possess the creative ideas and skills needed for innovation not only in AI, but in IT, as well as the ability to utilize and realize them; the "MITOU Advanced Program," which develops individuals that possess innovative ideas, etc. for utilizing IT and can apply them to solve business and social issues; and the "MITOU Target Program," which develops individuals in advanced fields that can drastically change the world by utilizing next-generation IT.

Source: Created by MEXT.

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1   National Institute of Technology, "Project for the Development of 'Future Engineering Human Resources for Society 5.0' at KOSEN (GEAR 5.0/COMPASS 5.0)."
     https://www.kosen-k.go.jp/about/profile/gear5.0-compass5.0.html

Gifu University aims to develop cutting-edge AI specialists, and has been certified under the "Approved Program for Mathematics, Data Science and AI Smart Higher Education." In addition, the university introduced NVIDIA Corporation's "Jetson Nano" extensively in the Faculty of Engineering's experimental course as practical AI education. Jetson Nano, while compact in size, is an edge computing device that can execute AI at a high speed. This subject promotes active learning in which students first understand the mechanism of edge AI, and then they design, implement, and evaluate AI projects by themselves. They understand image recognition, robot control, and voice recognition technologies using AI, and develop AI systems by embedding these technologies on Jetson Nano. They present and demonstrate their work, with an aim to acquire the certification "Jetson AI Specialist," which is NVIDIA's certification proving mastery of basic practical skills of AI and Jetson, in the end (Figure 1-2-10).

National Institute of Technology, Toyama College, (Toyama KOSEN) implemented an initiative in collaboration with local companies to survey the status of digital transformation (DX) and AI/utilization and to compile a report, and was selected under the "Approved Program for Mathematics, Data Science and AI Smart Higher Education – Literacy Plus" as the second college of technology to be selected (Figure 1-2-11).

Another unique initiative of Toyama KOSEN is to appoint external human resources for AI education as "AI side job teachers." In collaboration with BizReach, Inc. and the National Institute of Technology, Toyama KOSEN appoints private-sector human resources who use AI in business as teachers. These teachers teach AI technology that can respond to social changes and needs.

Mitoyo AI Society Promotion Organization (MAiZM), a general incorporated association

■ Figure 1-2-10/Students using the Jetson Nano tool kit
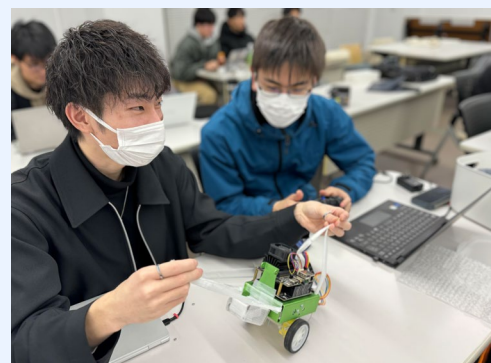

Photo courtesy of Gifu University, Tokai National Higher Education and Research System

■ Figure 1-2-11/Students conducting an online survey of a local company regarding the DX and AI/data utilization status

Photo courtesy of Toyama KOSEN.

established in April 2019 by Mitoyo City, Kagawa Prefecture, and Professor MATSUO Yutaka at School of Engineering, the University of Tokyo, conducts initiatives for developing human resources and solving issues of the local communities, such as organizing "AI Summer School" and supporting Matsuo Lab Startup, in collaboration with National Institute of Technology, Kagawa College.

In this chapter, we have looked at case examples of AI development in Japan. One of Japan's strengths is the long years of accumulation of experience and technologies in fields such as

automobiles, electronics, and robotics. While making the most of such industrial infrastructure, and with the high technical capabilities and R&D capacities of universities and research institutions, it is hoped that AI will be further developed and that innovation will be created through utilization of AI in a wide range of technical fields, and in the scientific fields introduced in Chapter 4.