AI Strategy 2019

AI for Everyone: People, Industries, Regions and Governments

（ *tentative translation* ）

June 11, 2019

Integrated Innovation Strategy Promotion Council Decision

Contents

Introduction

In recent years, artificial intelligence (AI) technology has developed at an accelerating pace, and found ever-increasing applications all around the world, greatly impacting a wide range of industry domains, social infrastructure domains, and other human activities. On the one hand, it is hard to argue that Japan possesses adequate competitiveness with regard to AI technology.

On the other hand, Japan, along with pursuing Society 5.0[1] and contributing to the solution of global issues (SDGs[2]), aims to create a "Circulating and Ecological Economy[3]," as a model for practical implementation in the field of Sustainable Development Goals (SDGs). And Japan must take action in advance of other countries to resolve many social issues faced by a mature society such as an aging population, shrinking population and deterioration of infrastructure. These issues are not problems that can be solved with technologies such as AI, but it is necessary to coordinate technology and social mechanisms in a transformational way in order to realize a "sustainable society that incorporates diversity".

At the March 2017 Artificial Intelligence Technology Strategy Council meeting, Japanese government drew up the Artificial Intelligence Technology Strategy and its Industrialization Roadmap, which designates "productivity," "health, medical care, and long-term care," "mobility," and "information security" as core areas of focus, where the public and private sectors will collaborate on

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[1] The 5th Science and Technology Basic Plan states "We will provide the necessary things and services to people who need them, and when necessary, respond precisely to the various needs of society, providing high quality services for all people, creating a society where all people can receive high-quality services and can live actively and comfortably, overcoming various differences in age, gender, region, and language." The Comprehensive Strategy on Science, Technology and Innovation 2017 states "Cyber and Physical Spaces should be highly integrated to provide products and services that meet the diverse needs and potential needs without disparities due to things such as region, age, gender, or language. This is a human-centric society that can balance economic development and social issues, and allow people to live comfortable, vibrant, high-quality lives."

[2] Sustainable Development Goals: The international goals from 2016 to 2030 described in the 2030 Agenda for Sustainable Development adopted at the UN Summit in September of 2015, consisting of 17 goals and 169 targets to realize a sustainable world, and pledge to leave no one on earth behind.

[3] In the 5th Basic Environment Plan (April 17, 2018 Cabinet Decision) "This Plan aims to create a "Circulating and Ecological Economy" that produces new value chains, complements and supports regional resources by building broader networks, which is composed of natural connections (connections among forests, the countryside, rivers and the sea) and, economic connections (composed of human resources, funds, and others), while making full use of mountainous, agricultural and fishing villages, and cities. Each region will demonstrate its strengths by utilizing its unique characteristics, thereby building a self-reliant and decentralized society where different resources are circulated within each region, and symbiosis and exchange with neighboring regions according to unique characteristics of each region."

AI technology spanning the full pipeline from R&D to social implementation. In August of 2018, an action plan oriented towards further embodying and strengthening the government's efforts based on this Strategy was put together; the action plan specifies the objectives and timetable for accomplishment for each initiative. However, with regard to the deployment of AI technology in domains such as big data, there has been an increasingly fierce battle for supremacy over the last few years among companies based in certain countries, notably the US and China, along with various disruptive innovations in various fields that defy conventional projections of advances, all of which has left Japan in a position of having falling behind. Conversely, some hold the view that because the extent of potential fields for introducing AI technology is so wide, competition in areas such as data collection and utilization in the field has just begun, and the decisive contest is yet to come.

Given this, in order to take the next step forward in overcoming issues facing Japan, making use of Japan's strengths to open up opportunities for the future, we will focus on measures that Japanese government should immediately take concerted action on, which are summarized in this Strategy.

I. Basic Concept

(A) Scope of the Strategy

The term "Artificial Intelligence (hereinafter AI)" in this Strategy presumes a system that realizes an intelligent function[4].

[4] AI (artificial intelligence), for example, in the EC High-Level Expert Group report, it is considered as "a system that performs intelligent operations (sometimes with certain autonomy) in response to environment and input", however, the substance of "intelligent action" also has an aspect that depends on interpretation. Also, the AI-100 report published in the US in 2016, cites the definition of Nils J. Nilsson that AI as a field of study is "research that makes intelligent machines, and intelligence works properly with some kind of insight in the environment where it is placed", but this definition has great ambiguity. In fact, in the same report, the vague definition of AI itself has a positive aspect that is accelerating AI research. In light of these circumstances, although there is a certain consensus regarding whether to judge something as "AI" or "AI technology", it is not meaningful to define it more strictly on the basis of the technology, etc. used there. At the same time, it should be noted that such a system is incorporated into a highly complex system. Furthermore, implementation of the AI system cannot be realized without the necessary infrastructure for large-scale data collection and storage, infrastructure access, ultra-high-speed communication networks, sensors, robots, and the like. Without the development and implementation of technology that ensures the safety and soundness of such systems, such as cyber security and AI ethics, it will be difficult for AI to be widely accepted. AI encompasses a wide range of systems that realize functions considered to be intelligent and is expected to extend into all domains, ranging from the society and industry of the future to daily life, scientific research and technology development. Accordingly, this strategy must address planning for all these domains in an integrated manner.

Although AI in recent years is mainly based on machine learning, especially deep learning, AI related technology is rapidly developing, and the definition of AI is not limited solely to technology used for AI.

(B) Purpose of the Strategy

The purpose of this Strategy is to specify the environment and measures conducive to effective future utilization of AI for the purposes of contributing to the solution of global issues through realization of Society 5.0 and overcoming the issues facing Japanese society.

This Strategy establishes an integrated policy package for AI that encompasses educational reform, research and development (R&D) and social implementation in order to contribute to the world, overcome challenges, and ultimately improve Japan's industrial competitiveness.

(C) Principles behind the Strategy

In March of 2019, the government compiled the "Social Principles of Human-Centric AI."

This document specifies the form of society that Japan should aim for, a multilateral framework, and a policy direction that the national and local governments should aim for as AI develops. It defines three points as its basic principles:

(i) Dignity - A society in which human dignity is respected

(ii) Diversity and Inclusion - A society in which people with diverse backgrounds can pursue their own well-being.

(iii) Sustainability - A sustainable society.

This Strategy respects these basic principles.

(D) Basic Concept for Strategy Promotion

In order to realize the basic principles of section (C) above, that is, to have a "sustainable society that incorporates diversity", it is important to introduce new technologies including AI in parallel with reforming social systems. Furthermore, it is essential that the introduction of AI yield benefits that are tangible to individual citizens and that new technologies and social systems are widely accepted.

In addition, while moving forward with the implementation of Society 5.0, Japan must improve its international presence and radically strengthen its industrial competitiveness. In doing so, as laid out in the "Social Principles of Human-Centric AI," it is important for diverse human resources, regardless

of their diverse backgrounds in terms of gender, age, political beliefs, and religion to be able to contribute based on a wide range of knowledge, perspectives, ideas, and so on.

The government, as the overall coordinator, bearing in mind the above-mentioned points, needs to steadily promote the various measures described in this Strategy while maintaining full awareness of the following points.

(i) The main players in industry are private sector companies, and for these companies to exercise their full capabilities, factors such as provision of foundations (training and recruiting of human resources, promotion of R&D, maintenance of the industrial base and support for commercialization), the establishment of a system to accelerate the introduction of new technologies and removal of impeding factors, and the establishment of a multinational framework are essential.

(ii) Implementation of the AI system requires, for example, large-scale data collection and storage, infrastructure for access, ultra-high-speed communication networks, sensor clusters, and robots.

(iii) In order to achieve the social acceptance of AI, it is important to develop and implement technology, including cyber security and AI ethics, that ensures system safety and integrity; to improve literacy related to AI; to have appropriate communication between developers/operators and users; and to foster recognition of the tangible benefits of AI.

(E) Strategic Objectives

The following strategic objectives are set for this Strategy.

Strategic Objective 1

For Japan to develop a base of human resources which, in proportion to population, leads the world in being aligned with the needs of the AI era, and to become a country that attracts human resources from around the world. In addition, to build a mechanism to achieve this objective on a sustainable basis.

"Human resources aligned with the needs of the AI era" are not a uniform type of person. They may be divided into various categories, such as

- People who carry out advanced AI research;
- People who apply AI to industry;

・People who realize application in small and medium-sized businesses;

・People engaged in new business creation using AI;

However categorized, each category needs to have a deep talent pool.

In order to deepen the talent pool, it is important to have strategies to develop and attract people according to their needs, including diverse human resources including women and people from overseas who aspire to work in Japan. Therefore, in the future, it will be important to establish a leading-edge education programs, and further, it will be necessary to enhance it to a level that can be offered overseas as well.

In daily life, more effective use of AI improves the convenience of life and enables people to do things that could not have been done without AI. However, in order to do so, it is necessary to raise people's literacy of AI and make it possible for each individual to appreciate and utilize the benefits of AI willingly and without anxiety.

Strategic Objective 2

For Japan to become a frontrunner in the application of AI to real-world industry and to achieve strengthened industrial competitiveness.

The "real world industry"[5] domain encompasses value-generating activities which cannot be fully executed within cyberspace, but only by interactions among people, nature, hardware, etc. This domain contains a vast amount of information that has not yet been systematically acquired.

In this domain, because in many cases it is extremely important to promote the transition to high value-added industries centered on service platforms, we aim to improve Japan's industrial competitiveness and secure and maintain a position as a frontrunner in the world by promoting AI related development support, system design, and laying of foundations for social implementation that contributes to this transition. This is an objective to be realized in conjunction with policies other than AI strategy, but there AI strategy unquestionably plays an important part. Labor productivity can be considered as a

[5] A generic term for industries that provide some value in the physical real world, such as medicine, agriculture, materials, logistics, and manufacturing equipment. In contrast to SNS and search services, it is characterized as not being completed within cyberspace, but creates value for the first time through interaction with people, nature, hardware, etc.

measure of industrial competitiveness. As a reference, in order to reach labor productivity levels[6] equivalent to those of other countries such as the US, Germany and France within the next 10 years or so, Japan must maintain a nominal labor productivity growth rate of over 6% for 10 years, making it clear that a very bold change in industrial structure is necessary. And concurrently, through this domain Japan can contribute to the achievement of SDGs on a global scale.

In addition, it is also important to aim at further improvement of service quality, improvement of the working environment, and ultimately the reduction of fiscal burdens by applying AI in the public service sector.

Note that the type of service industries that are almost completely in cyberspace, such as e-commerce and SNS, are a subject for future study.

Strategic Objective 3

For a series of technology systems to be established in Japan that will realize a "sustainable society that incorporates diversity", and to implement a mechanism to operate them.

It is extremely important for women, foreigners, elderly people and other diverse people with diverse backgrounds to be able to fully participate in society while enjoying diverse lifestyles. We will promote the establishment of AI-related diverse technology systems along with the creation of social systems and mechanisms to use them with the aim of individual citizen being able to enjoy tangible benefits.

In addition, this strategic objective is not intended to be limited in scope by Japan's borders; it is important to formulate a plan for implementation on the premise that promoting this objective on a global scale can significantly contribute to the achievement of SDGs.

Strategic Objective 4

For Japan to take a leadership role in building international research, education, and social infrastructure networks in the AI field, and to accelerate AI-related R&D, human resource development, achievement of SDGs, etc.

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[6] Nominal labor productivity (per hour) of major countries in 2017: US $72.0 USD, Germany $69.8, France $67.8, Japan $47.5 (all converted to purchasing power parity) (Source: Japan Productivity Foundation Headquarters "International Comparison of Labor Productivity in 2018").

With economic and social globalization rapidly advancing, objectives such as AI related human resource development/provision and industrial development cannot be fully accomplished solely within Japan, so we must always maintain an international perspective. For example, in human resource development and provision, it is necessary to provide many venues for overseas researches and engineers to be active in Japan, and to increase joint R&D and joint projects between Japan and foreign countries.

For this reason, in addition to strengthening collaboration with research and education institutions and companies in North America and Europe, we will fully engage in collaborations with regions having future growth prospects such as ASEAN, India, the Middle East, and Africa. We will provide AI related education programs to these areas, and take the opportunity of TICAD7 (Yokohama) to contribute to the promotion of AI research and commercialization in those areas. To achieve this, the core centers of the AI Research and Development Network, etc., in each priority area will need to clarify plans for which areas in which to conduct world-leading research and, with respect to emergent research, how to draw on an international talent pool in order to maintain the diversity of human resources and themes.

Additionally, in fields such as health, medical care, and long-term care, agriculture, and smart cities, we aim for international collaboration and cooperation at a scale that offers mutual advantages in terms of human resources, data and markets.

(F) Role Sharing Between Public and Private Sectors

A unified effort between the public and private sectors is essential to realize this Strategy.

Among these, by carrying out the following activities, the government 1will maintain an environment for the creation of a new society for the future (Society 5.0) and assiduously support private sector efforts towards the renovation of Japan's industrial structure through activities such as improving productivity, creating diverse value, and launching clusters of start-up companies.

- Development of strategy and formulation of a roadmap to realize it
- Immediate removal of institutional and policy obstacles
- Establishing networks for problem solving among multiple stakeholders
- Development of human resources including domestic and foreign workers
- Social implementation of social structure transformation and measures for the survival of the nation
- Fundamental R&D, next generation basic research
- Provision of a common environment for acceleration of AI utilization
- Ethics, formation of national and international governance systems
- Creation of a "global network" hub

It is necessary for the private sector, on the other hand, with full understanding of the purpose of this Strategy, to comply with the Social Principles of AI and to pursue international collaboration with other countries/regions and cooperation with diverse stakeholders while introducing an internationally competitive compensation system for talented human resources. Furthermore, for the sake of jointly creating the future, the private sector must actively contribute to future economic and social development with the awareness of their core role in undertaking a major challenge.

II. Building a Foundation for the Future: Education Reform and Reconstruction of the Research and Development System

II-1 Education Reform

Currently, our society is undergoing a major transition through digital transformation. One of the major driving forces of this change is AI, and there is the increasing demand for human resources capable of creating and using AI, designing new ways of society (a "sustainable society that incorporates diversity"), designing products and services suitable for the new society and creating new value. It is no exaggeration to say that this, coupled with the ability to collect, store and analyze big data, is one of the biggest factors determining the vitality of society and industry in the future.
For this reason, the training and securing of related human resources is an urgent and a long-term issues including primary and secondary, higher, recurrent[7] and lifelong education. Above all, it is important to have the ability to design new ways of society, products and services, based on the knowledge and skills related to "mathematics, data science and AI" and on humanities, social sciences and arts education. It will be essential to have radical improvement of traditional methods of education, introduce and strengthen new methods such as STEAM education[8], and perform cross-disciplinary learning for problem solving in the world.

Additionally, it is essential to have a strong understanding of the relationship between various social issues and science and mathematics from an early stage, and the experience of thinking to solve them with science and mathematics. In order to achieve this, it is also necessary to rapidly develop ICT infrastructure in schools, including an information education environment for each child student, and a school affairs support system for education.

Furthermore, if Japan can build new education model for mathematics, data science, and AI in the age of Society 5.0 in advance of other countries, it will be possible to strongly disseminate it to the world, especially to the Asian region.

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[7] This is education for working members of society, especially professionals, after completion of their regular schooling, and includes not only full-time re-education, but also includes part-time education while working.

[8] Cross-disciplinary education used to apply learning in individual disciplines including Science, Technology, Engineering, Art, and Mathematics to problem solving in the real world.

＜Main Objectives＞

The following goals for future education are set keeping in mind their realization by 2025, with the aim for human resources to be active in all fields of society and for all citizens to be cultivated the capability to participate in creating a sustainable society, the power which includes the knowledge and skills related to "Mathematics, Data Science, and AI", as the basic knowledge of the digital society (like the so-called "Reading, Writing, Abacus" basics), and the basic skills necessary to design new ways of society, products and services.:

- For all senior high school graduates to acquire basic literacy in "Science and Mathematics, Data Science, and AI". In addition, to foster creativity through the experience such as problem discovery and solving for designing new ways of society, products and services
- Cultivating human resources who understand data science/AI and can apply such understanding in their respective specialized fields (approx. 250,000 people/year)
- Identifying and training world-class human resources who can create innovations that fully exploit data science and AI (approx. 2,000 people/year, among whom approx. 100 people/year classified as top class)
- Conducting of recurrent education to many members of society to foster mathematics, data science, and AI (approx. 1 million people/year) (including recurrent education to promote women's social participation)
- Promotion of learning opportunities for international students in the fields such as data science and AI

＜Specific Objectives and Initiatives＞

(1) Literacy Education

[High Schools]

＜Specific Objective＞

For that all high school graduates (approx. 1 million graduates / year) to acquire basic knowledge of science and mathematics and basic information knowledge that forms the basis of data science

and AI. In addition, to experience problem discovery and solving for knowledge of humanities and social sciences and for designing new ways of society, products and services.

(Initiatives)

[Acquisition of Basic Information Knowledge]

- Based on the concept of data science and AI regarding the instruction methods of "Information Study I" (to be completed by FY 2022), development and national expansion of learning materials for teacher training (FY 2019) and constant improvement and enhancement of teaching methods [MEXT]
- Providing learning opportunities to improve data science and AI literacy of current teachers (FY 2020) [MEXT]
- Review of test questions for the IT Passport Exam[9] based on implementation of "Information Study I" (FY 2021) [METI]
- Reinforcement of AI related issues in the IT Passport Exam, etc. (FY 2019) and promotion of its utilization in high schools, etc. (FY 2022) [MEXT, METI]
- For all high schools to conduct practical training classes that form the basis of data science and AI, and create opportunity (IT related club activities, etc.) to challenge ambitious children and students to discover and solve problem with data science and AI (FY 2022) [MIC, MEXT, METI]
- Taking into consideration the situation of reviewing teacher training, in-service training, licensing of teachers, etc. making practical use of the flexible operation of the licensing system, and promotion of the recruitment of ICT-competent personnel, including doctoral students, postdoctoral personnel, engineers, data scientists and other diverse human resources in society (more than one in each school by FY 2024) [MEXT, METI]

[Acquiring Basic Knowledge of Science and Mathematics]

- Collection of good practices and promotion of their dissemination and enhancement of training in order to improve lessons from the perspective of proactive, interactive and authentic learning (active learning) in science and mathematics in high school (FY 2019) [MEXT, METI]

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9 This is a National exam for certification of basic knowledge about IT that all working people and students who utilize IT should have, The exam is one of divisions of the Information Processing Engineer Examination, in which Ministry of Economy, Trade and Industry, based on the "Law for the Promotion of Information Processing", certifies that an applicant's "knowledge/skill" as an information processing engineer is at a certain level or high.

- Teaching the methods that will be the basis of data analysis in high school to everyone (FY 2019) [MEXT]
- Keeping in mind the connection with mathematics and data science education in universities, etc., creating teaching materials to be able to learn basic knowledge of such things as probability, statistics, and linear algebra at the high school level. Providing instruction focusing on those who will enter universities, etc. (FY 2020) [MEXT, METI]

[Maintenance of ICT infrastructure and utilization methods]

- In order to accelerate ICT environment development at schools as a basis of the education mentioned above, through the cooperation of relevant ministries, examination and presentation of concrete measures such as how to utilize networks and the cloud in school, developing ICT environment models and guidelines on procurement of ICT equipment with necessary and sufficient functions, while also considering future data linkage, standardization, and flexible utilization (FY 2019) [IT, MIC, MEXT, METI]
- Examination and promotion of ICT utilization which contributes to reducing the burden at education sites (FY 2019) [IT, MIC, MEXT, METI]
- Examination and presentation of rules for such things as purchasing (renting), managing, updating and data linkage for student terminals, software, communication devices, etc. (FY 2019) [IT, MIC, MEXT, METI]
- Ultimately, in order to achieve an environment improvement such as hardware and networks where each student has a terminal and can make full use of ICT, setting goals and establish a roadmap with a view to using the cloud, introducing low-priced PCs, using networks and 5G communication, and BYOD[10] (FY 2019) [IT, MIC, MEXT, METI]
- Examination and implementation of specific measures for visualization, reliable maintenance and promotion of things such as the development status of the ICT environment and the utilization status of ICT (FY 2019) [MIC, MEXT]
- With regard to records such as learning logs and projects inside and outside of school, presentation of standard policies on such things as standardization and utilization, formulation

[10] Bring Your Own Device : Use personally owned devices

of procurement policies for ICT equipment, and protection of personal information (FY 2020) [IT, PPC, MIC, MEXT, METI]

- Maintaining an environment to learn knowledge and skills, and abilities to think, make judgement and express oneself necessary in the real world (Utilization of EdTech etc.) (FY 2022) [MEXT, METI]
- Early utilization of distance education at all desired high schools (by the end of FY 2024) [MIC, MEXT, METI]

[Fostering the competency needed to create a new society]

- Case construction and collection, model plan presentation and national expansion regarding of STEAM education through industry-academia collaboration and regional collaboration based on the viewpoint of curriculum management (FY 2019) [MIC, MEXT, METI]
- Preparation of a sustainable promotion system for implementing nationwide "IP creation education" that promotes the internalization of the idea of “creating something” and “valuing something created,” while encouraging development of education programs and improvement of usability of these programs (FY 2019) [IP]
- Establishment of an on-line library of contents STEAM education through industry-academia collaboration on global social issues (FY 2020) [MEXT, METI]

[University Entrance Exams and Finding Work]

- Investigation into use of the university standardized entrance exam "Information Study I" that incorporates CBT[11] for the administration of exam questions from FY 2024 (FY 2019) [MEXT]
- Implementation of measures for the industry to use learning history that saves learning outcomes and records of learning logs and projects inside and outside of school and whether a course taken was certified or not (see (4)) as a reference for employment activities (for example, providing a description column in job application form entry sheets) (FY 2020) [Re-Challenge, CSTI, MEXT, MHLW, METI]

11 Computer Based Testing

- Promoting entry sheets for university entrance exams and employment applications with description of academic achievements in science and mathematics, data science and AI (such as study results at school and the passing of extracurricular courses such as the IT Passport Exam) (FY 2021) [Re-Challenge, CSTI, MEXT, MHLW, METI]
- Regardless of the undergraduate fields of study being in humanities or sciences, enhancing the environment through a dramatic expansion in the number of universities that adopt "Information Study I" as an entrance examination and the emphasis on private school subsidies for that purpose (FY 2024) [MEXT]

[Universities, Colleges of Technology and Adult Members of Society]

＜Specific Objective 1＞

For all humanities and science university and college of technology students (approx. 500,000 graduates / year) to acquire an introductory-level competency in mathematics, data science and AI as part of their curriculum

(Initiatives)

- Development and national expansion of introductory-level standardized curriculum and teaching materials at universities and colleges of technology (FY 2019) [MEXT, METI]
- Adoption of introductory-level certified courses (see (4)) at universities and colleges of technology (FY 2020) [CSTI, MEXT, METI]
- Active support through focusing on such things as administrative expense grants and private school subsidies to universities and colleges of technology, taking into consideration the status of efforts such as introducing mathematics, data science and AI education into their curriculum (FY 2020) [MEXT]
- Ensuring an environment in which all university and college of technology students can register for introductory-level certified courses (see (4)) (including expanded utilization of MOOC[12] and The Open University of Japan) (FY 2022) [CSTI, MEXT, METI]

＜Specific Objective 2＞

12 Massive Open Online Courses

Offering a large segment of the workforce (approx. 1 million people[13]/year) the opportunity to acquire basic information knowledge and practical skills in data science and AI by any means available

(Initiatives)

- In places such as industry-academia forums and economic organizations, through sharing examples of excellent adult recurrent education programs (including programs that promote women's social participation), promotion of the practical use of results of attending recurrent education for job searching and hiring (FY 2019) [CSTI, Gender, MEXT, MHLW, METI]
- Further improvement of mathematics, data science and AI related skill sets (FY 2019) [METI]
- Promotion of vocational training for acquiring basic IT literacy (FY 2020) [MHLW, METI]
- Including women's social participation, maintaining an environment in which every member of society can study courses at universities, etc. when they want to learn mathematics, data science and AI (FY 2022) [Gender, MEXT, MHLW, METI]

＜Specific Objective 3＞

Enrichment of liberal arts education[14] for college students and working people (including fostering critical thinking skills to avoid accepting the results of one-sided data analysis and AI at face value)

(Initiatives)

- Promotion of liberal arts education, including humanities and science cross-disciplinary education at universities (FY 2019) [MEXT]
- Expansion of learning and study programs contributing to problem discovery and solving (promoting use for things such as job searching and hiring) (FY 2020) [METI]

[Elementary and Junior High Schools]

[13] Responding to literacy education of data science and AI with 25% (about 15 million) of the working population of approx. 60 million workers in Japan over the next 10 years, would set the annual number of approx. 10 million people (approx. 1 million people x 10 years) excluding the approx. 5 million new graduates of universities and colleges of technology generated in the same relevant period.

[14] Education that aims to provide general knowledge for thinking and judgment and to develop intellectual ability, unlike acquiring technical skills as vocational education.

＜Specific Objectives＞

In regards to the science and mathematics that forms the basis of data science and AI,

(i) Maintenance and improvement of the current status, in which Japan is among the world leaders in the ratio of high-proficiency

(ii) Boosting interest in science and mathematics, which is relatively low compared internationally

and ensuring the opportunities to understand and consider how science and mathematics relates to various social issues

(Initiatives)

- Taking into consideration the situation of teacher training, in-service training, licensing of teachers, etc. making practical use of the flexible operation of the licensing system, and promotion of the active recruitment of diverse human resources in society such as doctoral students, postdoctoral personnel, engineers, data scientists (more than one person in four schools by FY 2022) [MEXT, METI]
- Collection of good practices and promotion of their dissemination and enhancement of training, in order to improve lessons from the perspective of proactive, interactive, and authentic learning (active learning) in science and mathematics in all elementary and junior high schools (FY 2019) [MEXT, METI]
- Preparation of a sustainable promotion system for implementing nationwide "IP creation education" that promotes the internalization of the idea of “creating something” and “valuing something created,” while encouraging development of education programs and improvement of usability of these programs (FY 2019) [IP]
- In order to accelerate ICT environment development at schools, through the cooperation of relevant ministries, examination and presentation of concrete measures such as how to utilize networks and the cloud in schools, developing ICT environment models and guidelines on procurement of ICT equipment with necessary and sufficient functions, while keeping in mind the promotion of data linkage and utilization between schools (FY 2019) [IT, MIC, MEXT, METI]

- Examination and presentation of the rules for the purchasing, lending, managing, updating, etc. of computer terminals for children and students, software, communication devices, etc. (FY 2019) [IT, MEXT, METI]
- Ultimately, in order to achieve an environment improvement such as hardware and networks where each child student has a terminal and can make full use of ICT, setting goals and establishment of a roadmap with a view to using the cloud, introducing low-priced PCs, using networks and 5G communication, and BYOD (FY 2019) [IT, MIC, MEXT, METI]
- Visualization of things such as the development status of the ICT environment and the utilization status of ICT, and examination and implementation of concrete measures for reliable maintenance promotion (FY 2019) [MIC, MEXT]
- Case construction and collection, model plan presentation and national expansion regarding STEAM education through industry-academia collaboration and regional collaboration based on the viewpoint of curriculum management, model plan presentation (FY 2019) [MIC, MEXT, METI]
- Providing learning opportunities to improve the data science and AI literacy of current teachers (FY 2020) [MEXT]
- Presentation of basic policies on standardization and utilization with regard to records such as child student learning logs and projects inside and outside of school (FY 2020) [IT, PPC, MEXT, METI]
- Establishment of an on-line library of contents of STEAM education through industry-academia collaboration on global social issues (FY 2020) [MEXT, METI]
- Maintaining an environment to learn knowledge, skills, abilities to think, make judgement and express oneself necessary in the real world (Utilization of EdTech etc.) (FY 2022) [MEXT, METI]
- Early utilization of distance education at all desired primary and secondary schools (by the end of FY 2024) [MIC, MEXT, METI]

(2) Applied Basic Education

＜Specific Objective 1＞

For students in both humanities and science from a certain size of universities and colleges of technology (approx. 250,000 graduates[15]/year) to acquire basic skills to apply mathematics, data science and AI to their own fields of study.

To this end, we support universities that focus on selecting applicants in university entrance exams who will be able to acquire basic skills to apply mathematics, data science, and AI.

(Initiatives)

- Awarding of recognition of internships at universities and colleges of technology with high academic effectiveness, including fields of study in mathematics, data science and AI, and promotion of the wide adoption of good practices (FY 2019) [MEXT]
- Development and national expansion of standardized curriculum and teaching materials at an applied basic level in universities and colleges of technology (FY 2020) [MEXT, METI]
- Active support through focusing on such things as administrative expense grants and private school subsidies to universities and colleges of technology, taking into consideration the status of efforts such as introducing mathematics, data science and AI education into their curriculum (FY 2020) [MEXT]
- Introduction of certified courses at an applied basic level (refer to (4)) in universities and colleges of technology (FY 2021) [CSTI, MEXT, METI]
- Maintenance of an environment where students from a certain size of universities and colleges of technology (approx. 250,000 graduates/year) can experience learning and study of mathematics, data science, and AI in their own special fields by graduation (including the utilization and expansion of MOOC that include the use of excellent teaching materials from foreign countries, external experts, and the use of a system that allows the acquisition of double major degrees in AI and specialized fields of study) (FY 2022) [MEXT]

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15 Set as a goal, bearing in mind the number of university students per academic year (approx. 160,000) in science, engineering, agriculture and medicine and dental medicine departments, and about 30% (approx. 110,000) of the number of university students per year (approx. 370,000) from humanities and social science departments.

- Assisting universities that actively conduct university entrance exams to select students who are considered to be able to acquire applied basic skills in mathematics, data science, and AI (FY 2022) [MEXT]
- Through such things as the above-mentioned efforts, creation of an environment that enables students to take courses in fields of mathematics, data science and AI, and promotion of the acceptance of foreign students in these fields (FY 2022) [MEXT]

＜Specific Objective 2＞

Cultivating AI human resources for solving regional issues, etc. (with a target of approx. 1 million people / year)

(Initiatives)

- Expansion of mathematics, data science and AI related courses using e-learning, etc. in order to secure an opportunity to take part in the Certification System of Courses on IT-Skill Training to meet the era of the Fourth Industrial Revolution all over the country (100 courses in FY 2020) [METI]
- Promotion of applied basic education for regional personnel by public experimental and research institutes and national research institutes, and promotion of recurrent education for regional workers with the relevant personnel at the core (FY 2020) [MIC, MEXT, MAFF, METI]
- Maintaining an environment for local problem discovery and jointly solving, in which relevant players and projects are linked, such as local industries, universities, college of technology, specialized high schools and problem-solving type AI human resource development project (200 places throughout the country in FY2025) [MIC, MEXT, METI]

(3) Expert Education

＜Specific Objective＞

Cultivating expert human resources (approx. 2,000 people[16]/year, including approx. 100 people[17]/year classified as top class), and maintaining an environment where they can flourish to their full potential and create innovation.

(Initiatives)

- Development and expansion of education programs such as data science for graduate students and doctoral degree holders (FY 2019) [MEXT]
- Investigation into collaboration methods between contests and other events conducted by private organizations and university education (FY 2019) [MEXT, METI]
- Strengthening collaboration with universities, research institutes, research support institutions, etc. within Europe, the United States, Asia (Singapore, Vietnam, Thailand, India, etc.), Australia, the Middle East and Africa (utilized opportunity from TICAD7 (Yokohama)) (FY 2019) (relisted) (see II-2 (1-B)) [MIC, MOFA, MEXT, METI]
- Examination of measures to contribute to nurturing, discovering, and raising pointed talents regardless of age, including facilitating access to activities outside the school that will be "new learning places" (FY 2019) [CSTI, IP, MIC, MEXT, METI]
- Increasing overseas research opportunities for young researchers (FY 2020) (relisted) (see II-2 (1-B)) [MEXT, METI]
- Examination, implementation and international development of a system centering on PBL[18] to develop problem-solving type AI human resource who discover and solve problems using Data Science / AI (FY 2020) [METI]
- In exploratory IT Human Resources Project (The MITOU Program), establishment of a division that targets innovating information processing such as AI through practical or mathematical research (FY 2020) [METI]

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16 Set as a target based on the number of Japanese companies with capital of 1 billion yen or more (approx. 6,000)

17 Set as a target based on the number of industries in Japan (approx. 500)

18 Problem/Project Based Learning

- Promotion of R&D internships of human resources who have acquired an advanced education in mathematics (FY 2020) [MEXT, METI]
- Actively attracting international AI and related conferences and support therein (FY 2020) [CSTI, MIC, MEXT, METI, MLIT]
- Promotion of internationalization and diversity of universities and research institutes for the establishment of excellent foreigners, including the following (FY 2020) [CSTI, MEXT, METI]
  - Recruitment of foreign researchers and female executives
  - With a focus centering on joint research with foreign countries and support for foreign members, etc. responding gradually to the English conversion of the workplace and improving the ability of administrative staff to respond in English (raising up to a level that enables business to be conducted in English)[19]
- Development of an education program in collaboration with industry that fosters high-level human resources with AI and specialized fields of study (FY 2021) [MEXT, METI]

(4) Mathematics, Data Science, AI Education Certification System

＜Specific Objective 1＞

Establishment and promotion of a system for government certification of programs of excellence in mathematics, data science and AI education which count as credits for graduation from universities and colleges of technology

(Initiatives)

- In order to create a certification system, setting up a framework for discussions by parties concerned in places such as companies, universities, colleges of technology, and high schools, and examination of such things as certification methods, criteria for certification by level, and utilization in industry (FY 2019) [CSTI, MEXT, METI]

[19] Refer to Okinawa Institute of Science and Technology Graduate University (OIST). While in Japan, all work is being conducted in English.

- Recruiting and sharing good practices out of programs already implemented at universities, etc. as a reference for establishing the system (FY 2019) [CSTI, MEXT, METI]
- Building a certification system based on examination results and beginning course authorization (FY 2020) [CSTI, MEXT, METI]
- Investigation of the existence of equivalent systems in various foreign countries and starting discussions on international collaboration (expansion of utilization of certified courses, etc.) (FY 2020) [CSTI, MEXT, METI]
- Promotion of collaboration between schools and companies as follows:
  - Industry-academia-government collaboration to promote measures (for example, providing an column for entering information in entry sheets) by the industry to refer to the presence or absence of taking certified courses and the results of study at the time of employment (FY 2020) [Re-Challenge, CSTI, MEXT, MHLW, METI]
  - Promotion of examination and implementation of measures to collaborate and expand collaboration between the education and business worlds(for example, through such things as internships, recurrent education, employment of outside lecturers) (FY 2021) [CSTI, MEXT, METI]

＜Specific Objective 2＞

Promotion of widespread adoption of mathematics, data science, and AI related education programs/certifications/etc. which have been certified by the government for excellence

(Initiatives)

- Reinforcement of AI related issues in the IT Passport Exam, etc. (FY 2019) and promotion of its utilization in high schools, etc. (FY 2022) (relisted) (see (1)) [MEXT, METI]
- Expansion of mathematics, data science and AI related courses using e-learning, etc. in order to secure an opportunity to take part in the Certification System of Courses on IT-Skill Training to meet the era of the Fourth Industrial Revolution all over the country (100 courses in FY 2020) (relisted) (see (2)) [METI]
- Examination, implementation and international development of a system centering on PBL to develop problem-solving type AI human resource who discover and solve problems using Data Science / AI (FY 2020) (relisted) (see (3)) [METI]

II-2 Reconstruction of the Research and Development System

(Rapid raising of "Strategy and Emergence", and the establishment of a sustainable research system)

The business world globally, especially in Internet-based businesses, is currently driven by giant IT companies, mainly based in the US and China, which are engaged in extremely intense R&D competition in AI related fields, sparking a fierce global competition for human resources.

Japan's AI research has begun to lag noticeably in fundamental areas, exemplified by slowness to effectively utilize big data, knowledge, and computing resources, and inadequacy of applications contributing to social implementation. Combined with the relative decline of the Japanese economy in the global economy, it has now become difficult for Japan to conduct a domestic-only agenda for various AI related technology R&D. Moreover, this is also contributing to a delay in deployment of AI in complex sectors such as manufacturing, medical practice and mobility.

In Japan, there is a history of basic research, general-purpose research, and applied research in each sector developing independently in a decentralized fashion. While they have formed a group of AI-related core centers[20] with excellent capabilities in certain basic research, and public research institutes that have an excellent track record of applied research in specific fields, it is undeniable that there have been few crossover activities between them. From now on, in order to further improve Japan's AI related research capabilities and push forward with social implementation of research results, it is important for all the research institutes to cooperate and complement each other while demonstrating their own strengths, making it necessary to establish a R&D network centered on AI related core centers.

Among these, each AI-related core center is expected to continue to produce world-class results in each priority area and to become an international hub. So far, the Institute of Physical and Chemical Research (RIKEN) Center for Advanced Intelligence Project (AIP) has been researching and developing innovative fundamental technologies centering on theoretical research and integrally advancing them to the social implementation stage; the National Institute of Information and Communications Technology (NICT) is engaged in R&D focusing on natural language processing, multilingual translation,

[20] Includes the Institute of Physical and Chemical Research (RIKEN) Center for Advanced Intelligence Project (AIP), National Institute of Advanced Industrial Science and Technology AI Research Center (AIST AIRC), National Institute of Information and Communications Technology (NICT), Universal Communication Research Institute (UCRI), and the Center for Information and Neural Networks (CiNet)

multilingual speech processing, cognitive model building of the brain, and provision and social implementation of a usage environment including stored data; and the National Institute of Advanced Industrial Science and Technology (AIST) AI Research Center (AIRC) has mainly pursued social implementation centered on bridging (the practical application side) to companies with superior AI technology. Moving forward, RIKEN AIP aims to be the world leader in R&D of innovative fundamental technologies centering on AI theoretical research, NICT aims for the realization of interactive technology through innovative natural language processing using large-scale data, developing multilingual translation and speech processing technology including handling of foreign visitors from Asia and foreigners residing in Japan, and being the world's top leader in construction and application of a cognitive model of the brain aiming at the realization of heart-to-heart communication, and AIST AIRC aims to lead the world as the core research organization bridging AI based technology and society to real-world applications of AI. Additionally, each AI-related core center aims to rapidly transfer research results to find uses in society.

On the other hand, on the front lines of R&D, there is an urgency to deal with new issues such as ensuring the quality of AI, securing the reliability of the entire network, and responding to cyber-attacks. In order to respond to these issues, not only the linear extension of R&D conducted up until now, but also new engineering approaches and cross-disciplinary approaches are indispensable, as is quickly pivoting away from follow-up research that loses sight of Japan's strengths.

First of all, in order to make use of Japan's strengths and to revitalize Japan's future, (i) development of AI for the real-world domain and (ii) AI designed for inclusion will be the two major pillars of R&D. It is essential to construct a technological system aligned with these pillars, to push forward with basic research, and then advance to application and implementation. Additionally, as a premise of these pillars, it is important for Japan to establish a stack of technologies and operational know-how to develop AI with a high and reliable level of quality (Trusted Quality AI). This is important both in terms of reflecting the principles in the "Social Principles of Human-Centric AI" and in terms of establishing a competitive advantage.

In the application of AI to the real world domain, it is important to establish the theory, technology base, and development and operation process that will make the development of an effective AI system possible under the constraints of data of very high dimensionality with inaccuracy and incompleteness,

and in many cases, where a sufficient amount of data cannot be obtained. In addition, since the AI system is a system integrated with sensors, IoT, robots, infrastructure, etc., it is important to have a technology base on which these systems can easily be built. It is necessary to establish a R&D system that views the process in terms of the full pipeline from research results to social implementation.

Additionally, the cluster of technologies that support the realization of diversity and social inclusion, called "inclusion technology", has among its aims to realize the principles of universal design within a large framework linked to the pursuit of R&D oriented towards the development and implementation of inclusion technology and the realization of institutional reforms and digital government. At the present time, inclusion technology is not a well-established concept, and due to the nature of meeting diverse needs of diverse people, is not a single technology but rather a collection of diverse technologies. For this reason, it is necessary to identify technology, operation and organizational universality and to establish a new technology system. As an emergent research field, inclusion technology, while focusing on a number of themes with obvious applications, must at the same time progress towards creating diverse solutions for diverse needs.

Furthermore, when viewed from the perspective of medium and long-term innovation, it is critical to have emerging research oriented toward creating new value that cannot be predicted at the present stage, generating diverse seeds, and spurring cross-disciplinary integration at the basic research stage.

Consequently, we emphasize the diversity of R&D and set up the following four R&D approaches (programs):

(i) Basic research on AI and development of foundational technologies (AI Core)

(ii) R&D on applying AI to real-world industries

(iii) R&D on achieving inclusion through AI

(iv) Emerging research to pioneer blue-sky fields and technologies arising from a diversity of ideas

Among these, approaches (i) to (iii) are strategic programs, that is, programs based on recognition and prediction of technology trends, issues in Japan, and future directions, and are premised on a certain course of action and scenarios. In addition, (ii) and (iii) have aspects that require research based on diversity in problem identification and ideas, and a certain percentage will be implemented as a theme-oriented emergent research program.

The emergent research in approach (iv) should be a program that imposes no constraints on research content, based on the fact that research that leads to many disruptive innovations is actually being generated from non-focused areas. At the same time, it is necessary to design programs with an emphasis on diversity, under the hypothesis that emergent research is created from the integration of diverse human resources and disciplines. Also, in this context, it is necessary to establish a globally attractive system design and operation system.

In view of the difficulty of Japan going it alone in conducting various AI related technology R&D, we will make up for the shortage of domestic human resources in the future by attracting and exchanging international human resources, therefore recruitment and management of programs must be conducted in English.

＜Main Objectives＞

- Building of a comprehensive R&D cycle spanning basic research through social implementation in accord with this Strategy
- Securing cutting-edge Al technology that enables Japan to take leadership and international initiatives in standardization
- By strengthening and radically reforming AI related core centers in accord with this Strategy and creating a network with these centers at the core, creation of a Japanese model of AI R&D and promotion of the creation of attractive AI research centers selected by researchers around the world
- Strategically pursuing emerging research and fundamental and cross-disciplinary R&D that are key to realizing a "society that incorporates diversity and achieves sustainable development" as mentioned in this Strategy
- Driving of emerging research that is at the forefront globally and empowers world-class level research personnel to exercise freedom and creativity
- Building a research promotion system that incorporates global best practices

＜Specific Objectives and Initiatives＞

(1) Providing the Right Research Environment

(1-A) Construction of a Core Research Network

＜Specific Objective 1＞

Strengthening and radically reforming of the AI related core centers under the promotion system in accord with this Strategy

(Initiatives)

- With regard to the research and development at RIKEN AIP, AIST AIRC, and NICT AI related centers, in order to align such things as the R&D goals, systems and contents with this Strategy, establishment and promotion of a system centered on the AI strategy expert meeting for strength and promotion of the innovation, and set up and implement an action plan under the system (FY 2019) [CSTI, MIC, MEXT, METI]
- Reinforcement of a management system in line with this Strategy at RIKEN AIP, AIST AIRC, and NICT AI related centers (including team formation contributing to achievement of R&D items of this Strategy and recruitment of personnel) (FY 2020) [CSTI, MIC, MEXT, METI]

＜Specific Objective 2＞

Centering on AI related core centers, discovering and combining Japan's wisdom (including engineers who are strong in implementation, AI researchers, and researchers in basic mathematics and information science) working in cooperation with universities and public research institutes actively working on AI R&D, and constructing an "AI R&D Network" in line with this Strategy to provide opportunities for research and development

(Initiatives)

- In line with this Strategy, under the aforementioned promotion system, establishment of an "AI R&D Network" that ties AI related core centers and participating universities and research institutes (FY 2019) [CSTI, MIC, MEXT, MHLW, MAFF, METI, MLIT]
- Clarification of the role of AI related core centers in the "AI R&D Network" (FY 2019) [CSTI, MIC, MEXT, METI]
- At the National Institute of Advanced Industrial Science and Technology (AIST), which provides a bridge between fundamental research and the real world domain, carrying out the implementation and coordination of the direction of AI research for each organization in the "AI R&D Network", and establishment of administrative office for cooperative coordination with industry (FY 2019) [METI]

- Implementation of the following tasks in the "AI R&D Network" [CSTI, MIC, MEXT, MHLW, MAFF, METI, MLIT]
  - Promotion of participation of the National Agriculture and Food Research Organization (NARO), the Public Works Research Institute (PWRI), the Japan Science and Technology Agency (JST) the New Energy and Industrial Technology Development Organization (NEDO), and other major national research institutes and universities actively working on AI R&D (FY 2019)
  - Exchanging opinions on R&D status, formation of joint research, mediation of human interaction, and implementation of support for young researchers (FY 2019)
  - Selection and publication of good examples of AI R&D social implementation projects (FY 2020)
  - Participation and expansion of overseas members (FY 2020)
  - Promotion of human resources exchange and training, joint projects, etc. under this Strategy (FY 2020)

＜Specific Objective 3＞

Establishment of attractive R&D systems and infrastructure in line with this Strategy, selected from researchers around the world

(Initiatives)

- Development of a system environment (including sabbaticals, remuneration, management, language used, etc.) related to research and work and life for overseas researchers, foreign exchange students, and advanced AI human resources to be active (FY 2019) [MEXT, METI]
- Modularization of highly versatile element functions and construction of learning data sets for expanding private investment in AI research and development (FY 2019) [MIC, MEXT, METI]
- Identification of problems (handling of intellectual property, administrative procedures, etc.) in AI research and development and presentation of solutions to those problems (FY 2019) [CSTI, IP, MIC, MEXT, METI]
- Strengthening R&D closer towards the social implementation phase according to this Strategy at national research institutes, etc. (FY 2019) [CSTI, MIC, MEXT, MHLW, MAFF, METI, MLIT]

- Promotion of AI development that takes advantage of Japan's strengths by actively using domestic and foreign test beds[21] that can reproduce the real-world environment (physical space), convert machine and human information into data and research appropriate support methods using AI technology and robots (FY 2019) [METI]
- Strengthening collaboration among research institutes and funding agencies inside and outside of Japan (FY 2020) [MIC, MEXT, MAFF, METI]
- Trial introduction of English translation of funding application procedure for AI-related R&D and research activities (FY 2020) [Healthcare, MEXT, MAFF, METI]
- Development of a system to support freedom and creativity in basic emerging research at universities, etc. and support world-class level R&D (reprinted) (see (1-B)) (FY 2020) [MIC, MEXT, METI]
- Radically strengthening computing resources (such as ABCI[22]) contributing to AI R&D, formulating and promoting and open-close strategy for strategic data programs with a view to strengthening Japan's international competitiveness, and sharing computing resources among domestic research institutes (FY 2020) [MIC, MEXT, METI]
- Maintaining rules concerning the use of computing resources and networks from places such as the private sector, and commencement of use based on them (FY 2020) [MIC, MEXT, METI]
- International development of AI R&D results and promotion of international standardization (FY 2020) [MIC, MEXT, MAFF, METI]
- Substantial opening[23] and strengthening of ultra-high-speed research networks (SINET[24], etc.) to public and private universities, research institutes, companies, and all other researchers involved in AI R&D (FY 2022) [MIC, MEXT]

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21 For example, a cyber-physical system research environment including simulated environment (showcase) in the production field, the logistics field, and the drug discovery field, which was constructed in the “Cyber Physical System Research Building” of the National Institute of Advanced Industrial Science and Technology

22 AI Bridging Cloud Infrastructure: The world’s largest computing infrastructure for artificial intelligence processing operated by the National Institute of Advanced Industrial Science and Technology (AIST)

23 Connection standard compliance used to ensure the quality and safety of networks when connecting

24 Science Information NETwork (academic network): An information communication network constructed and operated by the National Institute of Informatics (NII) as an academic information infrastructure for universities and research institutes throughout Japan.

(1-B) Enhancement of the Emerging Research Support System

＜Specific Objectives＞

- Securing and fostering high-quality research personnel who lead the world
- Establishment of a research support system where researchers can continuously challenge emerging research
- Securing diversity of research (and researchers) to strengthen the intellectual basis of emergent research

(Initiatives)

- Examination of improvement measures to establish a research promotion system and preparation of a process chart for securing and fostering high-quality leading researchers in the world, promotion of international student exchange, increasing overseas research opportunities for young researchers, and gathering the wisdom of researchers around the world (FY 2019) [MIC, MEXT, METI]
- Aimed at securing diverse researchers, the trial basis introduction on AI related fields such as the conversion of research related administrative work including contracts into English and the simplification of office paperwork (FY 2019) [MIC, MEXT, MAFF, METI]
- Focused support for challenging research and research by young researchers based on their own free conceptions (FY 2019) [MIC, MEXT, METI]
- Strengthening collaboration with universities, research institutes, research support institutions, etc. within Europe, the United States, Asia (Singapore, Vietnam, Thailand, India, etc.), Australia, the Middle East and Africa (utilized opportunity from TICAD7 (Yokohama)) (FY 2019) [MIC, MOFA, MEXT, MAFF, METI]
- Establishment of a research support system that enables researchers to continuously challenge emerging research (reinforcement of an accompaniment support system for AI related research, etc.) (FY 2020) [MIC, MEXT, METI]
- Expansion of research support programs to meet the needs of diverse researchers (FY 2020) [MIC, MEXT, METI]
- Expansion of globalization of AI R&D in JST and other major national research institutes (FY 2021) [MIC, MEXT, MAFF, METI]

(2) Launch of Core Research Program: Promotion of Fundamental Integrated R&D

<Specific Objectives>

Systematization of fundamental and integrated technology of AI (AI Core), which is important for achieving the Main Objectives, in the following four areas, and strategically promote their R&D

1. Basic Theories and Technologies of AI
2. Device and Architecture for AI
3. Trusted Quality AI
4. System Components of AI

(Initiatives)

- Based on the overall structure of AI R&D below, referring to (Appended Table 1), creating a development pipeline chart in the field of AI related R&D (FY 2019) and reviewing it annually [MIC, MEXT, METI]

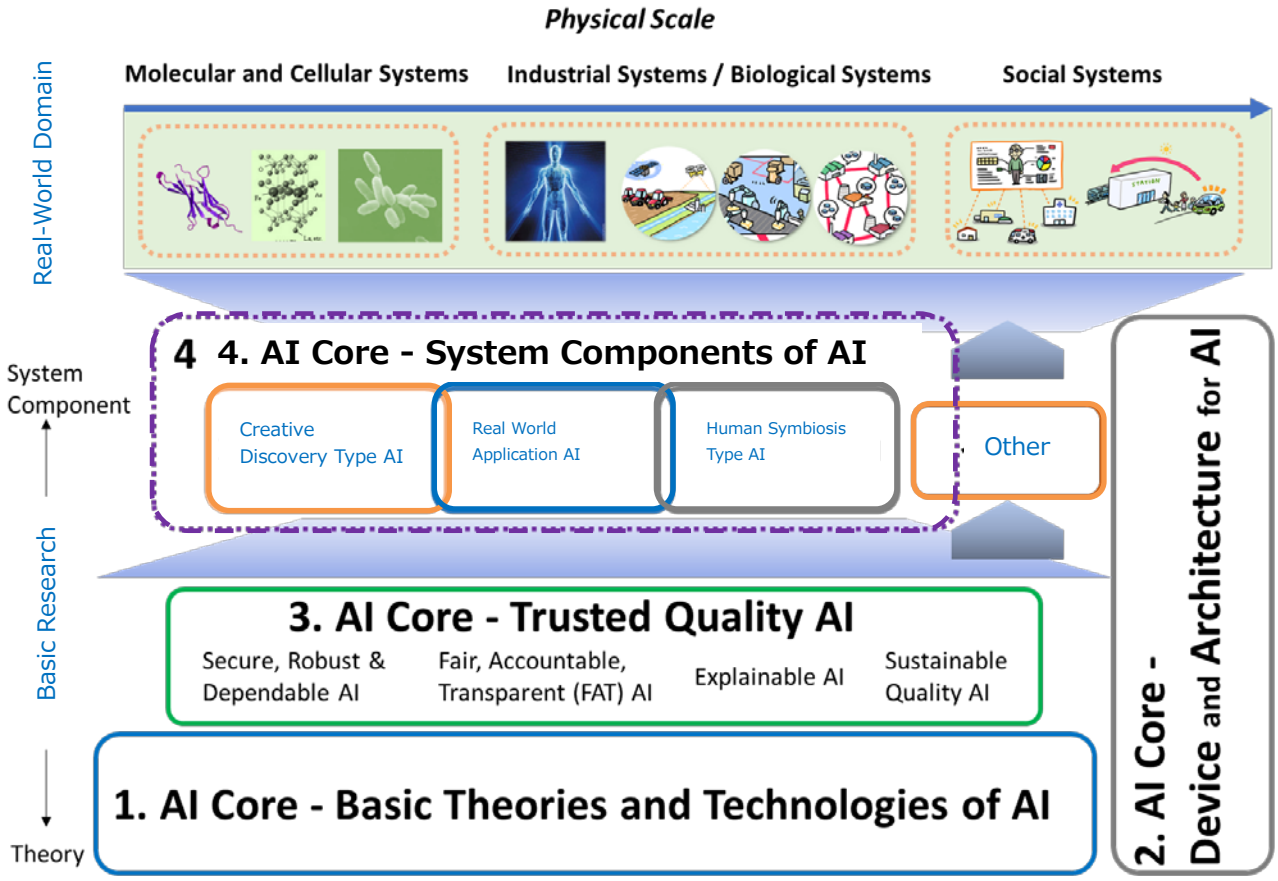


Figure: Overall Structure of AI R&D

III. Establishing a Foundation for Industry and Society

III - 1 Social Implementation

As already emphasized, by combining Japan's technology strengths with AI technology, we must aim to realize a "sustainable society that incorporates diversity" while contributing to the solution of global issues, creating substantial added value, improving productivity, and further strengthening industrial competitiveness.

In particular, the real-world industry domain is an area where Japanese companies have a large presence in the world at present. Consequently, Japan should be able to demonstrate superiority and take leadership in the realization of application of AI technology to the real-world industry domain (AI for Real World) and inclusion (AI for Inclusion).

However, in developing and deploying AI systems for the real-world industry domain, it is essential to provide domain-specific expertise and know-how, as well as deal with case-by-case factors, including operation. For this reason, in the current situation where the source of value has shifted to the service platform, settling for business models that are simply an extension of linear trends up to the present could result in Japanese industry losing preeminence, as hardware and other devices become terminals of service platforms,

At this point, first of all, as a sector-wide effort, in order to promote structural transformation to high value-added service industries (as measured by GDP per Capita, etc.) centered on AI-driven services and to dramatically improve productivity, it is necessary to develop architecture-based technology and form social implementation infrastructure.

Furthermore, the individual optimization of each domain is not enough; a system architecture must be designed to promote social implementation across fields. Designing such an architecture requires highly specialized system engineering expertise and experience; unfortunately, there is a critical shortage of such experts in Japan. For that reason, it is necessary to build a cross-ministerial promotion system, in reference to the efforts of organizations such as the United States' NIST[25], and working in cooperation

[25] National Institute of Standards and Technology

with relevant organizations in other countries, deploy Japan's limited number of specialists to conduct carry out system architecture design more efficiently and promote standardization.

The five areas of health, medical care, and long-term care, agriculture, national resilience (to disasters), transportation infrastructure and logistics, and regional revitalization are designated as priority areas. This is because Japan's top priority is finding solutions to social issues the country is facing, such as being the first country to face the full-blown effects of a declining birthrate and an aging population along with the resulting rapid increase in social security costs; decline in the workforce and shortage of healthcare and long-term care workers; extreme aging population of the agricultural workforce; the increase in disasters and damage to agriculture, forestry and fisheries due to climate change and extreme weather; and the aging and deterioration of infrastructure and the shortage of human resources to maintain infrastructure in regional Japan.

In the health, medical care, and long-term care fields, the medium and long term goal is to achieve better health for the public, improved levels of medical and long-term care, and an improved working environment for health-related workers while simultaneously reducing the burden on taxpayers.

In the area of regional revitalization (smart cities), this Strategy has foremost in mind regional cities (without excluding large cities). First of all, it is important to improve the quality of life in regional cities and regions and to nurture the development of local industries, but at the same time, aim to reduce the burden on local government finances.

In doing so, rather than prioritizing the logic of the infrastructure and service providers, the perspectives of diverse residents and local businesses should be emphasized. This approach is firmly rooted in the principle of "a sustainable society that incorporates diversity", and is expected to contribute to the realization of high value-added services in the region.

In addition, once social implementation of these five domains is realized in Japan, the high value-added services they generate can be expanded overseas, with unquestionable potential to contribute to the solution of global SDGs.

＜Main Objectives＞

To bring together the wisdom of industry, academia and government, setting the following goals, with the building of a framework for sustainable social implementation in mind:

- Based on a data infrastructure grounded in architecture design, being at the forefront globally in achieving AI social implementation in five key areas: (i) health, medical care and long-term care; (ii) agriculture; (iii) national resilience (to disasters); (iv) transportation infrastructure and logistics; and (v) regional revitalization (smart cities). In addition, undertaking efforts to achieve social implementation in manufacturing, finance and other fields
- Promotion of participation of private sector actors in social implementation models for each domain (including studying the prospects for rolling out the entire system in overseas markets)
- In health, medical care, and long-term care fields, maintaining an environment in which people feel assured that they can receive the most advanced and effective treatments as wells as high quality long-term care regardless of location, reducing the burden on medical care and long-term care providers
- In the agricultural sector, almost all the business farmers utilizing data in their workflow by 2025
- In the domain of national resilience, introducing a nationwide system to ensure the safety of infrastructure while minimizing maintenance and repair costs, and managing and sharing all types of data related to Japan's territory for that purpose
- In the transportation infrastructure and logistics domain, exploring how to build the data infrastructure for distribution and logistics; improving productivity and increase added value in logistics and efficiency improvement of the entire supply chain by linking with other data infrastructures, automation, etc.; enabling all people to enjoy freedom of movement and safety while doing so, without exceeding current social costs
- In the regional revitalization (smart city) domain, coordination with other domains such as agriculture and health, medical care, and long-term care, adoption of inclusion technology and building a smart city model that can also be rolled out to overseas markets.

＜Specific Objectives and Initiatives＞

(1) Health, Medical Care and Long-term Care

＜Specific Objective 1＞

Provision of a data infrastructure for utilization of AI in the health, medical care and long-term care fields

(Initiatives)

- Trend survey of AI development and utilization of health and medical care fields in foreign countries (FY 2019) [MHLW]
- Operation of a system for the smooth and fair use of anonymously processed medical information based on the Act on Anonymously Processed Medical Information to Contribute to Medical Research and Development (enacted on May 11, 2018) (FY 2019) [Healthcare, MEXT, MHLW, METI]
- Cross-disciplinary information infrastructure design in health, medical care and long-term care fields, accumulation of various data and establishment of an AI data infrastructure (FY2020) [IT, Healthcare, MHLW]
- Creation of a system for collecting data (living laboratories, etc.) linked to the region, in data obtained from daily life (FY 2020) [IT, MHLW]
- Building a framework to provide data and annotation and other infrastructure to partners (FY 2020) [MHLW]
- Exploring data infrastructure for sustainable AI development to support image diagnosis (FY 2021) [MHLW]

＜Specific Objective 2＞

Promotion of AI technology development in medical fields in where Japan has strengths and reducing the burden on healthcare workers through AI utilization for medical treatment

(Initiatives)

- Investigation into an AI application to drug discovery, toxicity evaluation, etc. (FY 2020) [MHLW]

- Investigation into utilization of AI in drug development other than mentioned above and medical practice (FY 2020) [MHLW]
- Construction of a framework for drug discovery target search using AI (FY 2021) [MHLW]
- Development and evaluation of image diagnosis support equipment using AI, and infrastructure development for social implementation (FY 2021) [MIC, MHLW, METI]
- Development of medical devices and telemedicine services (D to D) using AI, and evaluation of them, and development of infrastructure for their social implementation (FY 2021) [MHLW, METI]
- Development of early detection and diagnosis technology for diseases using AI (FY 2024) [MEXT, MHLW]

＜Specific Objective 3＞

Promotion of the introduction of AI / IoT technology to the field of prevention and long-term care, and reducing the burden on care workers by using AI / IoT for long-term care

(Initiatives)

- Starting examination of the provision of health maintenance / promotion services by the private sector, such as providing an opportunities for early awareness at a healthy stage utilizing health data (FY 2019) [IT, MHLW, METI]
- Development and introduction of a consultation system that introduces AI / IoT to long-term care facilities (FY 2020) [MHLW, METI]
- Implementation of prevention and long-term care field verification projects, and building a support system for AI start-up businesses in the same field (FY 2020) [MHLW, METI]
- Realization and national expansion of an AI system that supports high-quality long-term care services including utilization of knowledge of skilled care workers, etc. (FY 2021) [IT, MHLW]
- Review of the system side and operation side for the utilization of technology established for the verification project in the prevention and long-term care field (FY 2021) [MIC, MHLW, METI]
- Promotion of AI / IoT data utilization in the prevention and long-term care fields based on personal information controllability (FY 2021) [IT, MIC, MHLW, METI]

＜Specific Objective 4＞

Formation of the world's leading medical AI market and medical AI hub

(Initiatives)

- Preparation of a progress schedule chart for the promotion of AI development based on the roadblock cancellation process schedule selected at the "Consortium for Accelerating Development of AI in the field of Health and Medical Care" of the Ministry of Health, Labor and Welfare and an overview[26] compiled in the consortium (attachment) (FY 2019) [MHLW]
- Strengthening collaborative research such as AI development between companies (include foreign capital) and public institutions (such as public hospitals, universities, national research institutions) (FY 2019) [MIC, MEXT, MHLW, METI]
- Systematization of inclusion technology in the medical and long-term care fields (FY 2020) [MIC, MHLW]
- Based on the needs of each country under such initiatives as the Asia Health and Wellbeing Initiative, strengthening efforts including the following examples for cooperation with overseas (in particular, ASEAN member states and India) regarding data infrastructure, AI medical care, etc. (FY 2019) [IT, Healthcare, MHLW, METI]
  - Providing high-grade medical care to workers/ exchange students/ travelers coming from abroad and workers/ exchange students/ travelers going overseas (in cooperation with a series of measures already implemented, especially to aim to put into practice by focusing on the AI medical field where data accumulation is important)
  - Promoting the use of medical AI and data in government and certain institutions and expanding it to other institutions
  - Partnering with overseas medical institutions such as those in Asia in areas where AI implementation is proceeding such as Diagnostic imaging, cancer genome analysis, etc. and enabling access to a larger amount of data while promoting overseas expansion of AI medical system

[26] An overview regarding areas where development of and utilization of AI can be expected in the entire field complied in the "Consortium for Accelerating Development of AI in the field of Health and Medical Care" of the Ministry of Health, Labor and Welfare.

- Ultimately, contributing to one of the goals of the SDGs through realizing worldwide high-quality medical services by using AI (FY 2025)

＜Specific Objective 5＞

Education using AI in training facilities and training centers for medical professionals, and recurrent education for healthcare workers

(Initiatives)

- Examination of educational content using AI in training facilities and training centers for medical professionals (FY 2019) [MHLW]
- Examination of healthcare workers training that can develop and utilize AI (FY 2019) [MEXT]
- Establishment of a framework for AI education programs for adults for healthcare workers (FY 2020) [MHLW]

(2) Agriculture

＜Specific Objective 1＞

Implementation of smart agriculture technology corresponding to various items and regions including hilly and mountains areas

(Initiatives)

- Operation of the Agricultural Data Collaboration Platform (WAGRI), which has implemented an architecture for consolidating and utilizing various agricultural data (FY 2019) [IT, MAFF]
- Introduction of smart agriculture technology on site and starting demonstration as a consistent system from production to shipping (FY 2019) [IT, MAFF]
- R&D and demonstration of agricultural sensor devices and systems using AI (FY 2019) [IT, MEXT]
- Starting operation of a "Smart Food Chain System" and development overseas for export of agricultural and marine products and foods in Japan (FY 2023) [CSTI, IT, MAFF]

＜Specific Objective 2＞

Achieving the growth industrialization of agriculture by realizing the world's highest level of smart agriculture using architecture

(Initiatives)

- Building infrastructure to integrate data required for AI learning, etc. on the platform (FY 2019) [IT, MAFF]
- Formulation of contract guidelines to promote the use of agricultural AI services (FY 2019) [IT, MAFF]
- Conducting of R&D and demonstration of pest image diagnosis (FY 2022) [IT, MAFF]
- Implementation of a virtual research laboratory on WAGRI in which multiple breeding bases are lined (FY 2022) [IT, MAFF]
- Analysis and optimization of large-scale data of cultivation process (FY 2022) [IT, MAFF]

＜Specific Objective 3＞

Developing AI human resources in the field of agriculture

(Initiatives)

- Review and solving problems related to AI in OJT[27] by AI experts and AI researchers at the National Agriculture and Food Research Organization (NARO) [IT, MAFF]
- As a core human resource that develops AI research that can respond to various regional issues in cooperation with prefectural agricultural experiment stations and private sector companies, to foster researchers who possess high IT literacy including AI at the National Agriculture and Food Research Organization (NARO), and lead agricultural information research all over the country (FY 2022) [MAFF]

[27] On the Job Training: Teaching and educating the knowledge, techniques, skills, attitudes, and so on necessary for work through specific jobs.

(3) National Resilience (Infrastructure and, Disaster Prevention)

＜Specific Objective 1＞

Development and introduction of new technologies such as robots and sensors for inspection and diagnosis of critical infrastructures and aging infrastructures in Japan

(Initiatives)

- Promotion of the introduction of new technologies including AI and Big Data through actions represented in the Japanese Congress for Infrastructure Management (JCIM) (Introduce to 20% of facility managers by 2020 and 100% by 2030) [MLIT]

＜Specific Objective 2＞

Construction of Infrastructure Data Platforms to reproduce information about land in cyber space

(Initiatives)

- Integration and sharing of such things as structure data and ground data obtained in the entire construction production process ranging from surveying and investigation to design, construction and maintenance, and display them on the same map in coordination with local government data (building Infrastructure Data Platform and analysis trials) (FY 2019) [MLIT]
- Trial manufacture of a 3D model of a city (FY 2019) [MLIT]
- Drafting a roadmap for social implementation (establishment of full operation and sustainable operation system) of the platform (FY 2019) [MLIT]
- On the platform, integration of data on economic activities and natural phenomena, and development of an integrated data linkage infrastructure on land and traffic that reproduces real-world events in cyberspace (FY 2022) [MLIT]

＜Specific Objective 3＞

Carrying out resilience-oriented urban development utilizing AI that reflects Japan's experience with frequent natural disasters in recent years

(Initiatives)

- Development of information communications platforms that can analyze and summarize disaster related information on SNS in real time by utilizing natural language processing technologies and roadmap creation for it (FY 2019) [MIC]
- Development of secure and inexpensive hardware and networks using traffic lights that support social infrastructure in normal and disaster situations, with the aim of forming the world's top mesh network (FY 2020) [IT, NPA, MIC]
- Demonstration of a new technology in which multiple robots work together to extinguish fires autonomously to strengthen the response to large-scale and special disasters, optimization of functions of robots, promotion of cost reduction, etc. (FY 2020) [MIC]
- Based on past experience, AI analysis of data related to climate and data related to earthquakes, volcanoes, tsunamis and crustal deformation (observed data, projected data, etc.) and the establishment of technology to assess in advance the frequency of near-term extreme weather events and natural disasters, such as earthquakes and volcanoes (FY 2022) [MEXT]
- Development of an independent and distributed energy management system that is resistant to disasters (FY 2023) [MEXT, METI, MOE]

(4) Transportation Infrastructure and Logistics

＜Specific Objective 1＞

Reducing the number of accidents caused by human factors to zero

(Initiatives)

- Development of a data base to realize Level 2 autonomous driving on general roads and Level 4 autonomous driving on freeways (FY 2020) [CSTI, IT, NPA, MIC, METI, MLIT]
- Human factor verification at level 3 (FY 2020) [CSTI, IT, NPA, METI, MLIT]

＜Specific Objective 2＞

Minimizing the social costs associated with migration

(Initiatives)

- Introduction of an automatic detection / prediction system of traffic disorder occurrences using such things as camera videos recordings and AI image analysis, and promotion of the introduction of area based measures against general tourist traffic congestion based on the flow of people and vehicles and their analysis (FY 2020) [NPA, MLIT]
- Development of secure and inexpensive hardware and networks for using traffic signals as a trusted information hub (FY 2022) [IT, NPA, MIC]
- Establishment of Port Data Collaboration Platform to improve port logistics productivity (container logistics) (FY 2020) [IT, MLIT]
- In response to change in lifestyles, building and optimization of new regional transportation through the use of automotive CASE (Connected, Autonomous, Shared, Electrified) (FY 2023) [MOE]

＜Specific Objective 3＞

Productivity improvement and high added value in distribution networks using data obtained from distribution-related platforms

(Initiatives)

- Productivity improvement and high added value realized by accumulation, analysis, sharing and utilization of physical distribution and commercial flow data across individual company and industry boundaries, and examination of auto-recognition technology, etc. necessary for establishing infrastructure and the construction of a foundation to realize data coordination, taking into consideration private sector initiatives. (FY 2019) [CSTI, METI, MLIT]
- Realization of AI terminal by the development of a remote control and automation system that combines the expertise of superior skilled workers with AI, IoT, and automation technology (FY 2022) [IT, MLIT]
  - Gantry crane/remote control RTG[28] productivity improvement
  - Faster container damage checks
- Realization of autonomous ship to improve the efficiency of marine logistics (FY 2025) [MLIT]

[28] Rubber Tired Gantry crane

(5) Regional Revitalization (Smart Cities)

＜Specific Objective＞

From the three perspectives of facing social issues, the construction of a society that incorporates diversity, and the realization of digital government, reinvention of Japan's smart city, taking both infrastructure and user sides into consideration, development of an inclusion technology to realize this, and formation of a smart city platform

(Initiatives)

- Redefinition of smart city concepts (for example, mobility, healthcare, energy supply, etc.) including clarification of beneficiaries and high-impact beneficiary contents (FY 2019) [CSTI, MIC, MEXT, MHLW, MAFF, METI, MLIT, MOE]
- Building a common architecture of smart cities in collaboration between the public and private sectors (the first in FY 2019) [CSTI, IT, MIC, METI, MLIT]
- Recruitment and selection of smart city models that implement solution systems related to urban and regional issues and social issues across fields (FY 2019) [CSTI, Revitalize, MIC, MLIT]
- Systemization of inclusion technology and identification of R&D elements (FY 2019) [MIC, MEXT, MHLW, METI]
- Collection and analysis of data on energy consumption, feed personalized messages to each person, and promotion of energy saving behavior by combining behavioral insights such as nudge and boost with advanced technologies such as AI / IoT (BI-Tech) (FY 2019) [MOE]
- Establishment of a constant review system for the common architecture (FY 2020) [CSTI, MIC, METI, MLIT]
- Construction of a human-flow model in which core cities, local cities and overseas work together (FY 2020) [MIC, METI]
- Creation of new mobility services that combine mobility and services (for example, tourism, dining, agriculture, employment, medical care, education, digital government, etc.) using various data (for example, satellite positioning data) (FY 2020), and their overseas development [IT, Space, METI, MLIT, MOE]

- Establishment of an information infrastructure, system and AI service that enables such things as administrative services, medical care, long-term care, and education to be provided seamlessly between domestic and overseas smart cities (FY 2020) [CSTI, MIC, METI, MLIT]
- In order to improve satisfaction through effective and efficient responses to people such as foreign travelers, strengthening the information transmission function of the tourist information center using AI, etc. and promotion of things such as the discovery and utilization of hidden tourism resources in Japan through the analysis of things such as SNS data (FY 2020) [MLIT]
- Optimization of the whole area according to needs in all movements such as the movement of people and things (FY 2021) [IT, NPA, METI, MLIT]

(6) Miscellaneous

<Specific Objectives>

- Realization of AI social implementation in individual fields such as manufacturing and finance and between multiple fields
- Development of a social implementation promotion system for R&D

(Initiatives)

- Based on this Strategy, formulation of a concrete social implementation strategy for each field including areas other than the five priority areas, such as productivity improvement in the manufacturing field (considering such things as the integration of cyber physicals and role sharing between the public and private sectors) (FY 2019) [CSTI]
- Strengthening collaboration with universities, research institutes, research support institutions, etc. within Europe, the United States, Asia (Singapore, Vietnam, Thailand, India, etc.), Australia, the Middle East and Africa (utilized opportunity from TICAD7 (Yokohama)) (FY 2019) (relisted) (see II-2 (1-B)) [MIC, MOFA, MEXT, METI]
- In order to continuously lead the system architecture for promoting social implementation of R&D results in public and private fields, referring to the framework of NIST in the US, etc., establishment of an adjourning body for the coordination of a promotion system where related ministries and agencies cooperate to share cross-sectoral common issues and knowledge, and to form specific guidelines, focusing mainly on the broad range of areas addressed in this Strategy including R&D of such things as SIP[29]. Cooperation with funding agencies (FY 2019) [CSTI, IT, METI]
- Under the above mentioned adjourning body, building an organization by architecture design experts, and consideration to collaborate with organizations such as NIST in the US and related organizations in Germany (FY 2020) [CSTI, IT, METI]
- Based on the efforts made by the National Agriculture and Food Research Organization (NARO), carrying out on-the-job training on AI issues, etc. by AI experts and AI researchers,

29 Cross-ministerial Strategic Innovation Promotion Program

and development of a system for promoting social implementation of R&D at places such as major national research institutes. (FY 2020) [CSTI, IT, MHLW, MAFF, METI, MLIT]

III-2　Development of Data Related Infrastructure

The thing that fundamentally supports advances in AI technology is large amounts of data. It is extremely important to collect high quality data, keep it safe from risks such as cyber-attacks and use it for analysis.

For this reason, in order to keep pace with other countries, Japan also needs to work on coordination and standardization of data possessed by the government and the private sector. And in the process, prevent bias in big data and avert potential risks of AI utilization.

On the other hand, it is extremely important to ensure the trustworthiness of data, authenticity, and identify verification. In the United States there is already a trust infrastructure in the government procurement sector, and a common trust infrastructure in the EU is under construction. Japan has begun studying the issue, but, for example, we need to accelerate the consideration of measures to ensure the security of the entire supply chain ("Cyber Physical Security Framework").

＜Main Objective＞

Building a next-generation AI data related infrastructure premised on international collaboration

(1)　Data Infrastructure

＜Specific Objectives＞

Full-fledged operation of data linkage infrastructure for utilization of AI in five key areas (health, medical care, and long-term care; agriculture; national resilience; transportation infrastructure and logistics; and regional revitalization),

Implementation of initiatives to contribute to data quality verification and assurance for collected big data

(Initiatives)

- Examination of common data architecture in related Ministry projects, cooperation with each data exchange platform (FY 2019) [CSTI, IT, MIC, MEXT, MAFF, METI, MLIT]

- Provision of infrastructure and platforms for commonly used big data (e.g., agriculture, energy, health, medical care and long-term care, self-driving vehicles, manufacturing, distribution and logistics, infrastructure, disaster prevention, global environment, marine, and satellite data) (FY 2020) [CSTI, IT, Space, Ocean, MIC, MEXT, MHLW, MAFF, METI, MLIT, MOE]
- Establishment of network technologies that enable smooth exchange of huge amount of data in order to support the data linkage infrastructure (FY 2021) [MIC]
- Establishment of basic technologies that contribute to quality assurance by detecting bias and errors in big data collected via the data linkage infrastructure (FY 2022) [CSTI, MIC, MEXT, METI]
- Provision of an AI big data analysis environment linked to a data linkage infrastructure (FY 2023) [CSTI, MEXT]

(2) Trust & Security

<Specific Objective 1>

Establishment and maintenance of trust data linkage infrastructure that enables international mutual authentication with the US, Europe, etc.

(Initiatives)

- Identifying issues of underlying component technologies for trust, and formulate a government policy for their provision (FY 2019) [CSTI]
- Taking the following measures based on the "Cyber Physical Security Framework" to ensure the security of Society 5.0 [METI]
  - Development of security guidelines for each industrial sector (from FY 2019)
  - Beginning of examination of measures to ensure trustworthiness of connections in cyberspace (FY 2019)
- Building a cooperative system for security technology with the US and Europe (FY 2020) [METI]
- Proposal of an international standard for AI life cycle and AI quality assurance that includes data quality guarantees (FY 2021) [METI]
- Building a system for assurance/verification of authenticity that is spoof/tamper-proof (FY 2021) [CSTI, MIC, METI]
- Development of a trust data distribution infrastructure (access control, data, user rating function, etc.) (FY 2023) [CSTI, METI]

<Specific Objective 2>

To address increasingly complex and sophisticated cyber-attacks, establishment of highly efficient and sophisticated countermeasure technology using AI in each phase: "prevention", "detection" and "response"

(Initiatives)

- Provision of a mechanism to support private sector efforts to conduct cyber countermeasures using AI, and measures supporting technology transfer and commercialization of the results of government-supported research results (FY 2019) [METI]

- Clarifying R&D items that Japan should tackle and accelerate with priority, and with reference to Appendix 2, creating a process schedule for realizing the following technologies (FY 2019) [NISC, CSTI, MIC, METI]
  - AI for Prevention: detection of such things as malicious functions by grasping the operating characteristics of hardware, etc.
  - AI for Detection: attack method detection by massive packet information analysis, etc.
  - AI for Response: automatic extraction of alerts that require urgent response
- Examination of long-term efforts (techniques of protecting AI itself for ensuring cyber security, etc.) aimed at being realized in 5 to 10 years (FY 2019) [NISC, CSTI, MIC, METI]

(3) Networks

＜Specific Example 1＞

Promotion of the nationwide development of 5th generation mobile communication system (5G) and fiber optics, which are the core information communication infrastructures of the 21st century that support Society 5.0

(Initiatives)

- In the establishment guidelines for base stations for the introduction of 5G for carriers who receive certification of their establishment plan, the mandatory start of operation of 5G base stations in all prefectures by FY 2020 (FY 2019) [MIC]
- Promotion of 5G area maintenance by telecommunication carriers, etc. (from FY 2020), and promotion of maintenance of optical fiber networks supporting 5G (from FY 2019) [MIC]

＜Specific Example 2＞

Advancement of network infrastructure and securing of safety and reliability so that AI can be used all over Japan

(Initiatives)

- Formulation of a network vision that includes support for network virtualization that enables flexible network control (FY 2019) [MIC]
- R&D for innovative AI-based integrated network infrastructure technologies (automated network operation technology, automated network design technology) (FY 2020) [MIC]
- R&D for further advancement of 5G (FY 2022) [MIC]

III-3　AI Era Digital Government

The delay in computerization in the public services sector and the rapidly declining birthrate and aging population, especially in rural areas, have increased the administrative costs of local governments, while the labor shortage of administrative staff has become apparent.　That is, the so-called decline in productivity in the public sector has further progressed, and there is a strong desire for the use of AI related technology to solve this.

＜Main Objectives＞

- Promotion of complete digital government transformation, improved efficiency and convenience through the utilization of AI, and the realization of inclusion
- Implementation of administrative and policy planning based on appropriate data collection and analysis
- Promotion of cost reduction, work efficiency improvement, and advancement by utilizing AI and robotics in the local government administration field, and to secure sustainable public services

＜Specific Objective 1＞

Improving the convenience and productivity of public services using AI

(Initiatives)

- Based on the Basic Act on the Advancement of Public and Private Sector Data Utilization, open of various public and private data contributing to AI services, and increasing in opportunities for private use by API[30] integration with data collaboration platform (FY 2019) [IT]
- Trial introduction of AI for advancement and efficiency improvement of police activities (FY 2019) [NPA]
- Assignment of staff with expertise in data science, statistics, and AI in administrative agencies to facilitate data acquisition, analysis and AI application, and grant them authority to secure data integrity (FY 2020) [IT, MIC]

30 Application Programming Interface

- AI conversion of the research support administrative work of universities and national research institutes and administrative work of the country and funding agencies in order to reduce the burden on researchers (FY 2020) [MEXT, METI]
- Establishment of data acquisition and statistical data analysis platform in administrative agencies (FY 2020) [IT, MIC]
- Realization of a feedback loop of IT policies by the appropriate data analysis (FY 2022) [IT, MIC]
- Efficiency improvement of emergency transportation using AI (FY2022) [MIC]
- In order to make the most of the benefits of digital government transformation, building a platform that can receive all kinds of administrative services in multiple languages on mobile devices such as smartphones, and realization of the AI One Stop service (FY 2025) [MIC]
- Development and introduction of technology related to meteorological observation and prediction accuracy improvement (FY 2030) [MIC, MLIT]

＜Specific Objective 2＞

Promotion of the use of such things as AI and robotics for work efficiency improvement and advancement in order to reduce the administrative costs of local government and maintain public services

(Initiatives)

- Promotion of standardization of AI services that local governments can use with confidence (FY 2020) [IT, MIC]
- Implementation of robotics (RPA[31], etc.) to local government administrations (FY 2020) [IT, MIC]
- Promotion of local government administration smart projects (construction of standard and efficient business processes using ICT and AI etc.) (FY 2021) [IT, MIC]

[31] Robotic Process Automation : Automation of work process by robot on software

III-4　Support for Small and Medium-Sized Enterprises and Venture Companies

For a long time now, there have been calls for reforming the way of working in Japan, and now that a major improvement in Japan's overall productivity is required, the most pressing need for improving productivity is in small and medium-sized enterprises, where productivity is at a low level compared to large enterprises.

As utilization of AI technology advances, it promises to radically improve corporate productivity, but for that to happen, it is essential to increase AI literacy in companies, especially small and medium-sized enterprises (SMEs), and to promote matching between the technical needs of these companies and the required AI technology seeds.

Additionally, AI technology creates great opportunities to launch new startup companies. In fact, in the US and China, AI related venture capital investments are expanding rapidly, and many unicorn companies are emerging. Japan needs to provide an environment that encourages sharing of AI technology, effective utilization of AI in companies and government administration, and the creation of new products and services.

＜Main Objectives＞

- Provision of data infrastructure and improvement of productivity and growth potential through AI utilization in low-productivity and growth sectors
- Enhanced support for AI related business startups

(1)　Support for Small and Medium Enterprises

＜Specific Objective＞

Improving productivity of SMEs through utilization of AI

(Initiatives)

- Identification of the needs and issues of SMEs for problem-solving type AI human resource development projects (FY 2019) [METI]
- Launch and progression of new service models through solution of management issues by problem-solving type AI human resource development projects, regional universities, etc. (FY 2020) [MEXT, METI]

(2) Support for Young AI Related Entrepreneurs

＜Specific Objective＞
Support for AI related start-up companies

(Initiatives)

・ Implement measures based on the startup strategy "Beyond Limits. Unlock Our Potential" [CSTI, MEXT, METI]

IV. Ethics

While interest in utilization of AI is increasing, an excessive pursuit of making life in our civilization ever more convenient could amplify the negative ramifications of AI. In order to minimize this, a high ethical perspective that reflects the cultural background is important, and so-called AI social principles are needed in order to promote the use of AI in a way that respects human beings. In light of these concerns, Japan formulated its Social Principles of AI and announced them in March of 2019; the EU did so in April of the same year. Subsequently in May of 2019, the OECD Ministerial Council adopted a recommendation on AI and then in June, at the G20 Trade and Digital Economy Ministers' Meeting, agreement was reached on principles for AI around the concept of "human-centric".

Currently, in addition to Japan and the EU, countries such as Canada and Singapore are pursuing similar efforts, and discussions on ethics are also underway within international frameworks such as UNESCO and the G7. We can expect various debates around these issues, including about what new forms society should take, to become more and more active.

At the "International Conference of Data Protection and Privacy Commissioners", which brings together experts in the field, discussions about the development of guidelines which adhere to principles of AI ethics and data protection have begun.

<Objective>

Dissemination of the Social Principles of AI and establishment of an international collaboration system

(Initiatives)

- Establishment of seven AI social principles on social framework in the AI-Ready society of " Social Principles of Human-centric AI" (FY 2020) [CSTI, MIC, MEXT, MHLW, METI]
- Establishment of a multilateral framework on the social principles of AI, including consideration for the prevention of ethics dumping[32] (FY 2021) [CSTI, PPC, MIC, MOFA, MEXT, MHLW, METI]

[32] Ethics dumping: Conducting unethical research in countries/regions where ethics rules are loose.

V. Miscellaneous

As previously mentioned, the social and technological contexts surrounding AI have been rapidly changing and developing in recent years.

Meanwhile, the United States, China, Europe, Canada, and various Asian countries, have formulated national AI strategies, and in Europe and Asia there has been a surge in international cooperation and international joint R&D among AI research centers in order to carry out these strategies.

Japan must seize the opportunity that such a social environment presents to actively strive to secure international leadership in AI related fields.

In addition, in light of the fact that Japan is the G20 chair country and TICAD7 will be held in Japan this year, it is important to keep in mind that cooperation with developing countries, where interest in AI is expanding -- especially in Africa -- should be included in the scope.

＜Main Objective＞

Securing Japan's leadership role in the international community on AI related technologies

＜Specific Objective 1＞

Regular follow-up and review of this Strategy

(Initiatives)

- Building an AI strategy / AI social principles follow-up system in which diverse stakeholders collaborate (AI strategy expert meeting for strength and promotion of the innovation), conducting follow-ups, and reviewing this Strategy as needed (FY 2019) [CSTI]
- Examination towards realization of Intellectual Property systems, etc. to take advantage of Japan's strengths in accordance with the initiatives of this Strategy (FY 2019) [IP, METI]

＜Specific Objective 2＞

Raising Japan's global profile in organization, development, implementation, etc.

(Initiatives)

- G20 agreement on collaboration for AI ethical principles (FY 2019) [CSTI, MIC, MOFA, METI]

- Contribution to TICAD7 (Yokohama) regarding AI human resource development, support for social implementation, etc. (FY 2019) [CSTI, MIC, MOFA, METI]
- Packaging AI related data, apps, etc. for international development (FY 2020) [MIC, MHLW, MAFF, METI, MLIT]
- 100 (approx.) top AI researchers/year invitation from around the world to Japan (FY 2020) [MIC, MEXT, METI]
- Attracting and supporting AI related international conferences such as the IJCAI[33] (FY 2020) [CSTI, MIC, MEXT, METI, MLIT]

[33] International Joint Conference on Artificial Intelligence: to be held in Yokohama in 2020.

（Appended Table 1）Core Foundation Research and Development

Future R&D Priority Items	Individual Items	Concrete Initiative Details	Achievement Period	Agency
1. AI Core – Basic Theories and Technologies of AI	Solving difficult problems that cannot be matched with current deep learning	While clarifying the current principle of deep learning, the development of the next generation AI based technology as shown below ・Limited information learning technology that can learn with high accuracy even in situations where a complete correct answer label cannot be obtained ・Parallel search technology that can achieve high computational efficiency even with hundreds of thousands of parallels ・Causal reasoning technology that can identify causality even when unobserved confounding factors exist, etc.	FY 2024	[MEXT]
	R&D of innovative natural language processing technology and speech processing technology	R&D of the following innovative natural language processing technology ・Knowledge acquisition technologies to extract semantic/discourse relations, such as causal relation, between sentence level expressions from a large amount of text ・Practical context processing technology ・Question answering and hypothesis generation technology that answers based on a large amount of text ・Data-driven modeling of dialogue considering the deep motivation and intention of the speaker	FY 2030	[MIC]
		R&D of the following innovative speech recognition and synthesis technology ・High-accuracy technology that recognizes verbal information and real-world event information from multilingual speech and environmental sounds that overflow the real world ・Speech synthesis technology that outputs appropriate information as natural speech information without stress	FY 2025 FY 2025	[MIC]

		・Development of technology that can accurately recognize even speech at daily conversation levels by referring to world knowledge, context and non-speech information that is essential for communication in the real world	FY 2035	
	R&D of AI technology using a brain model	Stepwise R&D below to clarify the cognitive mechanism of the brain and to use brain models ・AI technology that enables learning from sparse data by following the brain mechanism ・AI technology that directly estimates the content perceived by people when viewing video, etc. ・AI algorithms that can process various information by imitating the process of brain information processing	 FY 2019 FY 2025 FY 2040	[MIC]
2. AI Core – Device and Architecture for AI	Edge-Oriented computing devices	Development of innovative sensors, actuators, etc. for self-contained flexible modules	FY 2022	[MEXT]
		Establishment of advanced AI chip technologies that improve power consumption performance of information processing by 10 times or more compared to conventional technologies	FY 2022	[METI]
	Cloud computing devices	Development of storage class memory that consumes less than a fraction and has a storage capacity more than 100 times that of DRAM	FY 2025	[MEXT]
	Next-generation computing devices	Creation of qualitatively secure information processing technology with quantum information processing	Study with Quantum Strategy	[MIC]
		Creation of massively parallel, large-scale information processing technology by quantum computing technology, and its application to AI	Study with Quantum Strategy	[MEXT]
		Establishment of technologies such as quantum computers that improve power consumption performance of information processing by 100 times or more compared to conventional technologies	FY 2027	[METI]
		Development of architecture which can process information in practical time, imitating the brain	FY 2050	[MIC]

Future R&D Priority Items	Individual Items	Concrete Initiative Details	Achievement Period	Agency
3. AI Core – Trusted Quality AI	Technology that encourages the protection and distribution of personal data	Establishment of privacy protection technology that contributes to promoting the circulation of personal data, etc.	FY 2025	[MEXT]
	Resolving ethical issues of AI based on scientific points of view	Development of theories and techniques for data, algorithms, operations, etc. that eliminate broad biases	FY 2025	[MEXT]
	AI technology that can be explained	Theoretically clarification of the current principles of deep learning, etc. and making it possible to understand the basis of judgment results of deep learning Development of explanation technology to easily understand AI judgment or help human judgment	FY 2025	[MEXT, METI]
	Quality assurance of output from AI	With a view to high-risk real-world applications in mind, clarification of the scope of the purpose for developed AI, and development of methods to evaluate the quality of the AI within that scope, etc.	FY 2025	[METI]
4. AI Core – System Components of AI 4-1. AI for Creation Discovery	Materials R&D using computational science and AI in industry, academia and government	Acquisition of high quality and huge data essential to AI analysis by making the research environment smarter, construction of a data platform that accumulates and provides them, and acceleration of data driven research through its utilization	FY 2022	[MEXT]
	Promotion of integrated R&D of AI and simulation	Creation of results contributing to the solution of social and scientific issues by utilizing new scientific methods that combine AI and simulation	FY 2024	[MEXT]
	Research of scientific discovery by AI	Development of an AI scientist that performs hypothesis generation, design of experiments, automatic execution of experiments, verification of results, etc. for experimental verification at the cell level	FY 2030	[MEXT]
4-2. Real World AI	Social Knowledge Extraction Technology for Real-world react to Real-time Text Stream	Development of real-world social knowledge extraction technologies that link locations and events in the real world to the ever changing social knowledge that is circulated on diverse Internet media such as SNS by extracting, organizing and summarizing with high accuracy the huge amount of texts that flows in real time on such media at each time point	FY 2025	[MIC]

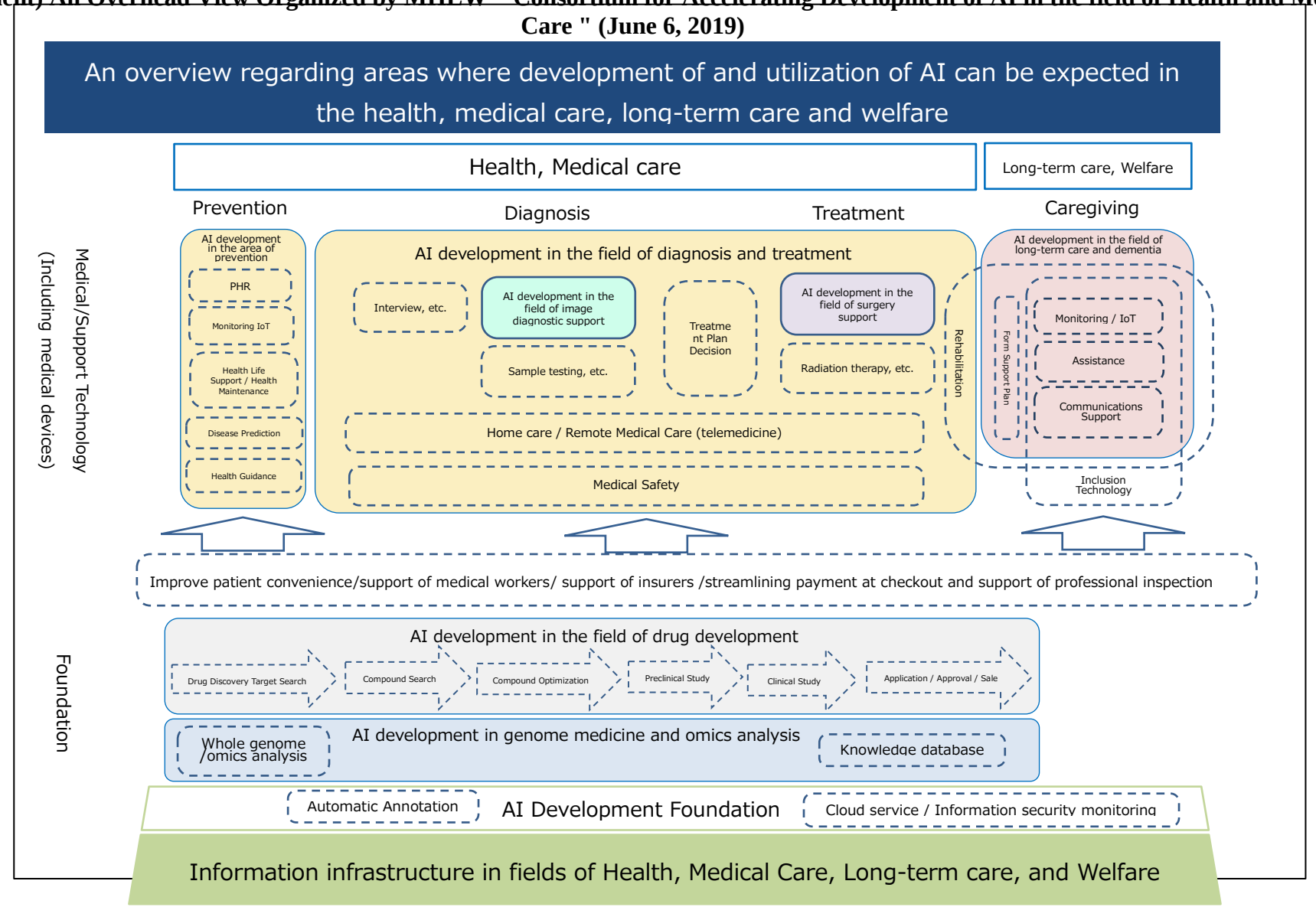
Future R&D Priority Items	Individual Items	Concrete Initiative Details	Achievement Period	Agency
	Adapting the latest machine learning technology and complementary technology to real world issues and areas that are Japan's strengths, promoting fusion R&D	Development of a software platform (middleware framework) that implements the latest machine learning theory	Started in FY 2019	[MEXT]
		Development of an analysis system that implements a new basic technology of machine learning in the fields of medicine, biotechnology, manufacturing, new materials, disaster prevention and mitigation, boundaries, and knowledge bases	Started in FY 2019	[MEXT]
		Development of AI to consult with the deployment of AI for business and value creation by AI	FY 2023	[METI]
		Development of technology that dramatically accelerates the introduction of AI, such as automatic optimization of hyper parameters set in advance when performing machine learning, development of AI technology that reproduces the tacit knowledge of skilled workers in manufacturing, etc.	FY 2023	[METI]
	R&D collaboration by industry-academia-government in priority areas that should be addressed consistently from foundation to implementation	While making maximum use of world-class demonstration research facilities and computing resources, conduct R&D for technology fusion of simulation technology, ontology technology, computational engineering technology and robot technology required to solve new problems that arise in the application of AI technology to real-world fields such as long-term care, distribution, and transportation	FY 2023	[METI]
	Establishment of AI based technology to innovate manufacturing processes	Realization of a simulator that predicts appropriate processing parameters by utilizing AI technology for laser processing	FY 2022	[MEXT]
	AI that obtains new knowledge from combined analysis of satellite data and ground-based data	Building a platform that can combine satellite data and ground data to perform complex AI analysis	FY 2022	[MIC]
4-3. Human symbiotic AI	Practical spoken dialogue technologies and human interaction technologies	Development of spoken dialogue technologies that can provide novel ideas or awareness to users through brainstorming or chitchats by exploiting data-driven dialogue models, context processing technologies, and a	FY 2030	[MIC]

		large amount of high-level knowledge acquired by knowledge acquisition, question answering, and hypothesis generation technologies		
	AI human interface	Development of technology that facilitates highly autonomous AI and human collaboration and smooth task delivery	FY 2025	[METI]
	AI co-evolving with humans	Development of co-evolution AI that can understand contexts and meanings, respond to unexpected events, and enhance each other's abilities through human interaction	FY 2030	[METI]
	An AI that translates and interprets beyond the language barrier	Staged implementation of the following translation technologies that can be used without stress: ・Can be used in specific situation (medical care, administrative procedures, daily life and travel, business, etc.) (conversation level) ・Can be used while supplementing the speaker's intention, taking into consideration the surrounding situation and cultural background (discussion level) ・Can be used even in severe negotiations (negotiation level)	FY 2020 FY 2025 FY 2030	[MIC]
	General-purpose multilingual automatic translation, simultaneous interpretation technology	Realization of simultaneous interpretation at practical levels that achieve high accuracy and minimization of delay by combining the following basic technology development with speech recognition and synthesis ・General-purpose, multilingual, multi-sector automatic translation that can be received and sent only in Japanese in all fields such as dialogues, SNS, academic papers, and newspapers with little performance degradation even if there is no or very few parallel texts ・Technology to achieve high accuracy within practical reaction rates by capturing information beyond one sentence	FY 2025	[MIC]

（Appended Table 2）AI Application Development and Demonstration for Cyber Security Measures

Future R&D Priority Items	Individual Items	Achievement Period	Agency
AI for Prevention	Automatic vulnerability diagnosis using knowledge base	FY 2022	(private sector led)
	Automatic assessment of the severity of newly registered vulnerability information on target systems	FY 2022	[METI]
	Malicious functions detection by grasping operating characteristics of single hardware based on fuzzing technology, etc.	FY 2022	[MIC, METI]
	Development of a system for carrying out the technical inspections to verify that malicious programs and circuits are not built into the devices and software	FY 2022	[NISC, CSTI, MIC, METI]
AI for Detection	Automatic detection of unknown / new malware by AI utilization in detection logic	FY 2022	(private sector led)
	Automatic classification of malware function system by automatic analysis using a large amount of malware information	FY 2022	(private sector led)
	Automatic grasping and detection of attack methods and attack tendencies by utilizing AI technology for any massive amount of packet information that is presumed to be attacks	FY 2022	[MIC]
AI for Response	Forensic analysis support by AI	FY 2022	(private sector led)
	Automatic extraction of alerts that truly require urgent response from security alerts	FY 2022	[MIC, METI]
	Partial automation of association with threat intelligence information	FY 2022	[METI]

(Attachment) An Overhead View Organized by MHLW " Consortium for Accelerating Development of AI in the field of Health and Medical Care " (June 6, 2019)



The following are the abbreviations of the departments and ministries in charge that appear in square brackets [ ] in each (**Initiatives**) section. (In the case of multiple departments and ministries, the main one in charge is underlined)

Abbreviation	Formal Name		
IT	Cabinet Secretariat	Information and Communication Technology (IT) Strategic Office	
Healthcare		Office of Healthcare Policy	
Re-Challenge		Assistant Deputy Secretary	
NISC		National center of Incident readiness and Strategy for Cybersecurity	
CSTI	Cabinet Office	Director General (Council for Science, Technology and Innovation)	
Gender		Gender Equality Bureau	
Revitalize		Regional Revitalization Promotion Bureau	
IP		Secretariat of Intellectual Property Strategy Headquarters	
Space		National Space Policy Secretariat	
Ocean		National Ocean Policy Secretariat	
NPA		National Public Safety Commission	National Police Agency
PPC		Personal Information Protection Commission	
MIC	Ministry of Internal Affairs and Communications		
MOJ	Ministry of Justice		
MOFA	Ministry of Foreign Affairs		
MEXT	Ministry of Education, Culture, Sports, Science and Technology		
MHLW	Ministry of Health, Labor and Welfare		
MAFF	Ministry of Agriculture, Forestry and Fisheries		
METI	Ministry of Economy, Trade and Industry		
MLIT	Ministry of Land, Infrastructure, Transport and Tourism		
MOE	Ministry of the Environment		
MOD	Ministry of Defense		

List of other abbreviations used:

ABCI	AI Bridging Cloud Infrastructure
AI	Artificial Intelligence
AIP	RIKEN Center for Advanced Intelligence Project
AIRC	Artificial Intelligence Research Center
AIST	National Institute of Advanced Industrial Science and Technology
API	Application programming interface
ASEAN	Association of Southeast Asian Nations
BI-Tech	Business Intelligence Technology
BYOD	Bring your own device
CASE	Connected, Autonomous, Shared, Electrified
CBT	Computer based testing
CiNet	Center for Information and Neural Networks
D to D	Doctor to doctor
E-commerce	Electronic commerce
EU	European Union
EdTech	Education technology
FY	Fiscal Year
G7	Group of 7 (Canada, France, Germany, Italy, Japan, UK and US)
G20	Group of 20 (19 countries and the EU)
ICT	Information and Communications Technology
IJCAI	International Joint Conferences on Artificial Intelligence
IoT	Internet of Things
IT	Information Technology
JAIST	Japan Advanced Institute of Science and Technology
JCIM	Japanese Congress for Infrastructure Management
JST	Japan Science and Technology Agency
MOOC	Massive On-line Open Course
NARO	National Agriculture and Food Research Organization
NEDO	New Energy and Industrial Technology Development Organization
NICT	National Institute of Information and Communications Technology
NII	National Institute of Informatics
NIST	National Institute of Standards and Technology (U.S.)
OIST	Okinawa Institute of Science and Technology
OJT	On the job training
PCs	Personal computers
PWRI	Public Works Research Institute
R&D	Research and Development
RIKEN	Institute of Physical and Chemical Research
SDGs	Sustainable Development Goals
SINET	Science Information NETwork
SIP	cross-ministerial Strategic Innovation Promotion Program
SMEs	Small and Medium Enterprises
SNS	Social Networking Service
STEAM	Science, Technology, Engineering, Art, Mathematics
TICAD7	Seventh Tokyo International Conference on African Development
UNESCO	United Nations Educational, Scientific and Cultural Organization
UCRI	Universal Communication Research Institute