Toward AI for Human Beings: Human Centric AI Zinrai

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The demand for information and communications technology (ICT) has grown remarkably in recent years, with customers wanting to leverage it to transform their on-site work and create new business opportunities through innovations. In this climate, the deployment of artificial intelligence (AI) is attracting special interest. In the Fujitsu Group, Fujitsu Laboratories has been the hub of the research and development of AI since the 1980s, aiming to realize its practical application. Today, our knowledge and expertise in AI are integrated into a structured system—Human Centric AI Zinrai (hereafter, Zinrai). Based on Fujitsu's knowledge and know-how gained through cutting-edge research, Zinrai comprises the component technologies of sensing and recognition, knowledge processing, and decision-making and support, together with learning technologies that allow these features to be enhanced and grow. Fujitsu takes a unique approach to AI because these technologies are organically integrated to facilitate an ICT environment that helps enrich people's lives and society. This paper presents contextual accounts of AI development at Fujitsu, and describes innovative technologies that represent the four areas of technology within Zinrai: learning, sensory-media, knowledge, and mathematics. It also gives some accounts of collaborative initiatives with our customers to promote the AI business.

1. Introduction

Artificial intelligence (AI), which was first proclaimed at the Dartmouth Conference in 1956, reached its 60th anniversary in 2016. AI, which has developed as one of the ultimate goals of computer science, is beginning to reach a major milestone in the form of concrete application cases, and has a striking impact, in various fields from society and daily living to industry. The magnitude of this impact is giving rise to discussions about the potential of AI to bring about a major revolution called the fourth industrial revolution, as well as concerns about the "Singularity," which refers to the time when AI will rise above humans in terms of intelligence.

This paper first reviews the history of AI until now, and goes on to relay Fujitsu's views about current AI. It also gives an overview of the features of Human Centric AI Zinrai (hereafter, Zinrai), which refers to Fujitsu's knowledge and expertise in AI, integrated into a structured system presented by Fujitsu as its AI technology brand. This paper introduces also leading-edge AI technology born of research led by Fujitsu Laboratories, and gives an overview of business development activities using AI.

2. History of AI until the present day

AI is currently showing unprecedented growth across industry, including and beyond ICT, but it has a surprisingly old history. The initial boom of AI was the period from the late 1950s to the first half of the 1970s. The term AI was first used in 1956 at the Dartmouth Conference held at Dartmouth College and attended by researchers in the U.S.[1] However, as it was mathematically proven that AI at that time could only solve simple problems (toy problems), the boom waned.

Thereafter, from the beginning of the 1980s, the second boom arrived, when a large number of ICT companies, Fujitsu included, began developing and selling expert systems supporting business activities. Later, in the 1990s, computers beating chess champions became a big topic. However, AI in that period had not yet reached the level where computers could learn and

make judgments on their own, and activities consisted mainly in people teaching computers their knowledge. At the time, it was difficult to teach computers human knowledge and to manage them, and again AI entered a dormant period.

However, from the 2010s, a new technology called "deep learning" was thrust into the limelight in the field of machine learning, and the AI boom was on again. Deep learning is a leading-edge neural network technology that simulates the mechanisms of the human brain. In AI technology until then, trying to extract characteristics from a large amount of data required that humans teach AI the method (algorithm) to do so. By contrast, in deep learning, the computer itself is able to acquire knowledge. This advance was made possible by the spread of the Internet and big data, the greater ease of obtaining vast amounts of data, improvements in the processing power of computers, and advances in machine learning algorithms.

This breakthrough of a machine acquiring its knowledge on its own, overcoming the traditional limits of AI, is considered to have unleashed the third AI boom of recent years.

3. The kind of AI aimed for by Fujitsu

Fujitsu has been developing AI technology since the second AI boom of the 1980s, with Fujitsu Laboratories at the lead. Along with accumulating a wealth of technologies and know-how until now, Fujitsu has also conducted numerous joint developments and demonstration experiments with external research institutions such as universities.

In this way, Fujitsu has steadily been carrying out technical development and offering products applying the technological advances thus achieved. However, as Fujitsu did not integrate these technologies into a structured system as AI and promote this externally, Fujitsu's AI solutions have failed to gain broad recognition in the marketplace. Zinrai was launched as Fujitsu's AI technology brand for promoting the AI technology of Fujitsu.[2)]

Zinrai is the integration of Fujitsu's AI technology into a structured system. "Zinrai" is derived from the Japanese *shippu-zinrai*, which means "fast as lightning." This naming choice comes from the fact that Zinrai offers great speed to support human decision-making and action, and is a dynamic driver of AI-based innovation both for industry and society. Further, "Human Centric AI" denotes Fujitsu's vision. Some in the media assert that AI will rob people of work, but we believe that AI is not a dream tool that will be able to do everything instead of people. The AI that Fujitsu envisions is a "collaborative, human centric AI," and we are aiming for the realization of AI that support greater business growth and efficiency for our customers.

4. Features of Zinrai

In conjunction with its announcement of Zinrai, Fujitsu has integrated AI technology into a structured system ahead of competitors (**Figure 1**).

Let us take a look at the flow of data in Figure 1. First, the data is captured with sensors from the real world at the top of the figure. AI then performs sensing and recognition using the captured data. Next, the sensed and recognized data is processed into knowledge that computers can understand. Then, using this information processed into knowledge, decision-making and support beneficial for business are carried out, and last, the results are applied to the real world (actuation). AI component technologies are embedded in these processes, and these technologies are organically coordinated to form one large system capable of recognition and judgment exceeding the ability of humans, achieving what is broadly regarded as AI.

In this way, Fujitsu considers AI as a broader concept. For example, with regard to sensing, it will be important to determine how AI can wisely sense data using the Internet of Things (IoT). Further, the processing of acquired data will naturally include the use of existing big data technology. Also, it is expected that, of the feedback from the results then processed by AI systems, that actuated in the real world will include robotics and other technology.

As shown in **Figure 2**, Zinrai consists of four technology categories, namely learning technology, sensory-media technology, cognitive technology, and mathematical technology. In the next section, we will explain these four technology categories.

5. The four technology categories of Zinrai

- Learning technology

Learning technology is technology that aims to achieve for computers the ability of humans to learn

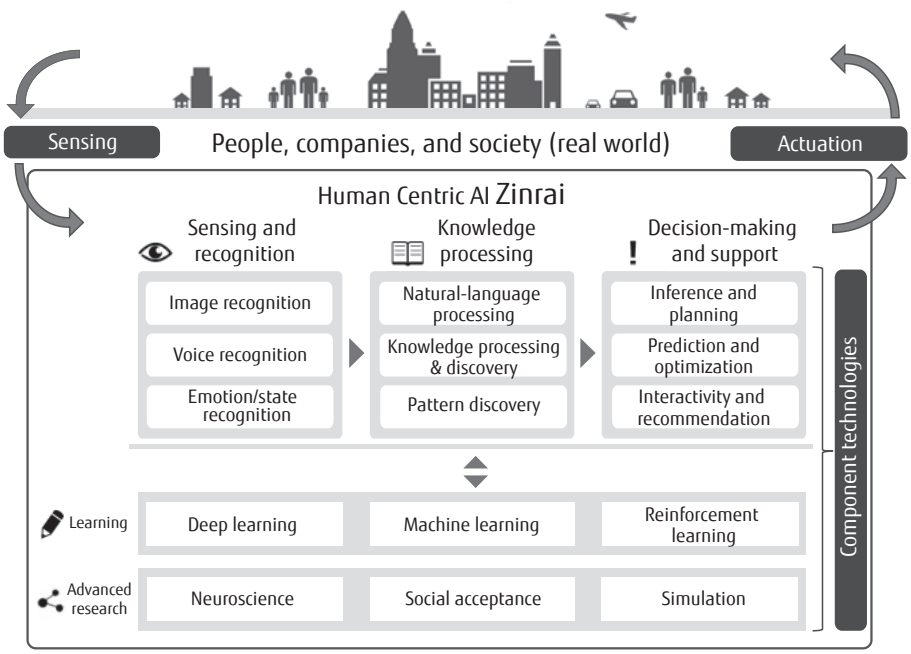

Figure 1
Turning Fujitsu's AI technology into a structured system.

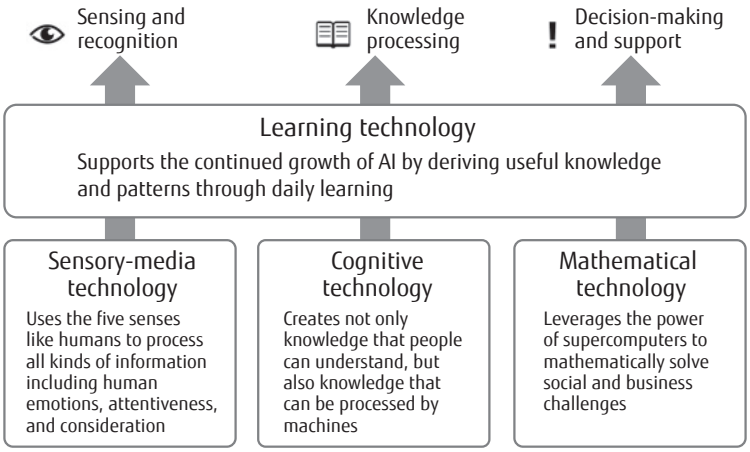

Figure 2
The four technology categories of Zinrai.

from experience. Its significant feature is that it allows AI to make judgments and grow just like humans, based on daily learning. Specifically, AI can then automatically find laws, patterns, knowledge, and the like from a variety of data such as images, sound, numerical values, and text, and apply these findings to stocktaking of the current situation, future prediction, and decision making. In Zinrai, this learning technology supports sensing and recognition, knowledge processing, and decision-making and support, and can thus be said to be fundamental technology that promotes the continued growth of AI.

A case of learning technology is handwriting recognition technology for the Chinese language (**Figure 3**). This technology learns and stores a very large number of character pattern characteristics. Handwritten characters vary in shape according to the person who writes them, and for AI to recognize

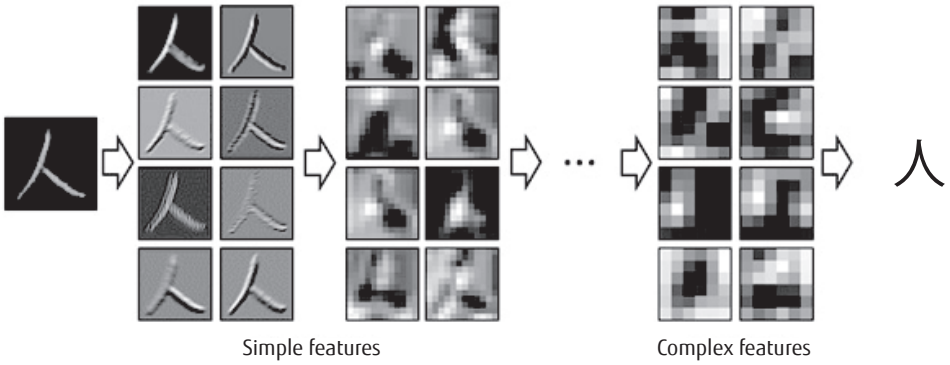

Figure 3
Recognition of handwritten Chinese.

characters written by different persons as being the same character requires a learning mechanism that is capable of learning about a wide range of variations. We developed handwriting recognition technology that is capable of automatically generating a wide variety of character patterns to be learned using a proprietary deep-learning technology.[3] AI capable of learning extremely finely the characteristics of characters has achieved a recognition rate of 96.7%, which exceeds human recognition ability of Chinese handwritten characters. This advance holds promise for more efficient processing of handwritten forms, among other things.

- Sensory-media technology

Fujitsu aims to achieve "AI that assists people where they work and live in a natural way" with human-like attentiveness and consideration. A key technology for achieving this is sensory-media technology. Whereas media technology senses through images, sound, and the like, the reactions and behavior of people such as their voices, facial expressions, and gestures, sensory-media technology unleashes the power of proprietary information processing algorithms combined with extensive knowledge of business professionals to achieve AI that is capable of processing even the emotions, attentiveness and consideration of people.

Applications of sensory-media technology include support for the provision of personalized services through the accumulation and analysis of data on the reactions and behavior of people based on captured sensor data. For example, the use of line-of-sight detection sensors in retail stores allows the capture of fine

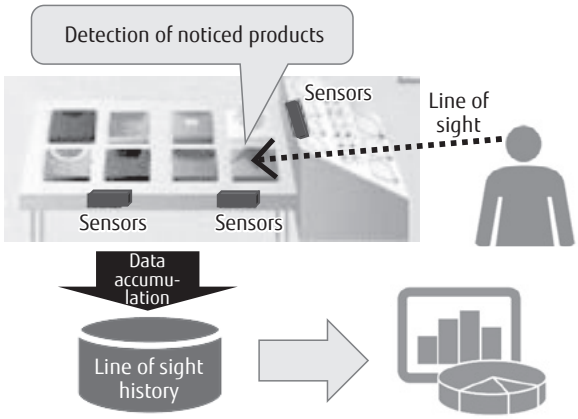

Figure 4
Realization of advanced digital marketing using sensory-media technology.

changes in the line of sight of people, enabling detailed detection of the things and places people look. Taking advantage of AI in retail spaces will make it possible to go beyond simply knowing what people look at, and to estimate the interest people have in particular products and even their psychological state. This could be used to improve marketing activities by predicting the process by which customers compare products and mull over then before settling on the product they purchased (**Figure 4**).

- Cognitive technology

With the advent of the IoT era, the amount of information that people obtain in the course of their daily lives is dramatically increasing. What is now needed is technology to instantly extract valuable information from the enormous amount of information

that is available and make it usable. Fujitsu has been working on developing AI technology for extracting the most useful knowledge from a wide variety of data. That technology is cognitive technology. By processing knowledge that computers can easily understand from the information produced by people and analyzing it, AI can support human decision-making.

Cognitive technology can for example be useful for supporting lending decisions in the audit work of banks. Audit work in the financial industry involves the verification of numerous documents such as account books. In many cases, different notation styles are used even for the same company (for example, "Fujitsu Ltd.", "Fujitsu Limited"). By leveraging cognitive technology, it will be possible to load specific data of the Financial Supervisory Agency, financial documents of banks, as well as open data from sources such as social media sites and Wikipedia, and use this as a database allowing analysis from various perspectives. AI will become able to make flexible decisions like people. As a result, even if different styles of notation are used for the same company, computer-assisted name identification will be possible, which has the potential to make audit work at banks much more efficient.

- Mathematical technology

The utilization of big data, which has been a focus of attention in recent years, is now spreading beyond the sphere of business to fields where it contributes to society, collectively called the social domain. Concretely, this is a movement that seeks to utilize big data actively in various fields such as disaster prevention, education, transportation, agriculture, and health in daily life. Regarding the use of enormous amounts of data, it is important to also take into account the impact such use may have on the behavior and psychology of the users, and to accordingly perform optimization for the usage purpose. Fujitsu believes that AI technology can make contributions in this area based on mathematical technology.

One example of our activities in this area is our participation in the Todai Robot Project "Can a Robot Get Into the University of Tokyo?" [4), note)] This project led by the National Institute of Informatics was launched in 2011, and Fujitsu has been participating in the mathematics team of this project since 2012. Since university entrance examination problems are expressed in natural language that people use, computers must first clear the hurdle of correctly understanding the exam questions, and deriving the correct answers has proved to be difficult. To meet this challenge, Fujitsu combined its proprietary mathematical formula processing technology with natural language processing technology (**Figure 5**). This led to scoring a deviation value of 65.8 on the Mathematics II B section of the Shinken Comprehensive Academic Skill Multiple Choice Mock Exams in 2015.[5)] Currently, we are steadily making progress toward our goal of passing the University of Tokyo entrance examination in fiscal 2021.

6. Promotion of the AI business

Fujitsu has set itself the goals of incorporating AI technology into FUJITSU Digital Business Platform MetaArc (hereafter, MetaArc), achieving the integration of Systems of Record (SoR) and Systems of Engagement (SoE) and the transformation of business, and evolving this into a key factor for stimulating innovation (**Figure 6**).

As a first step, Fujitsu has begun offering AI utilization consulting services to support the application

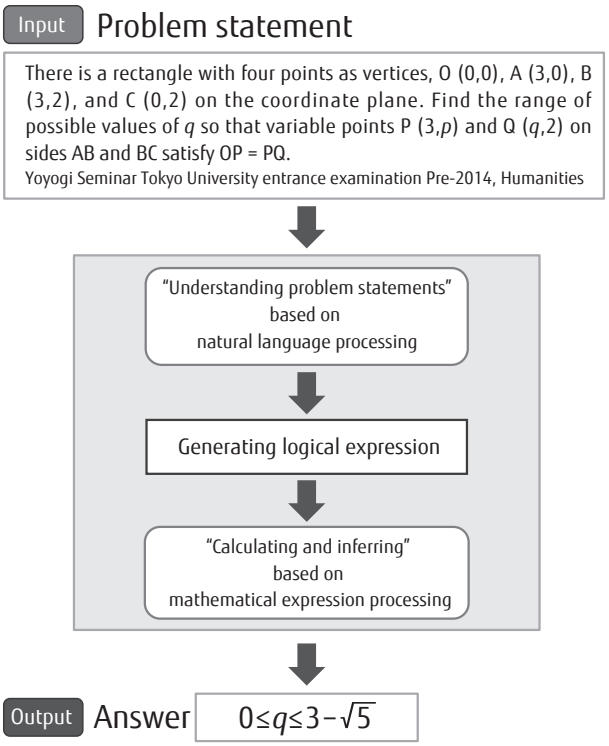

Figure 5
How the Todai Robot solves mathematical problems.

note) The University of Tokyo is also known as Todai.

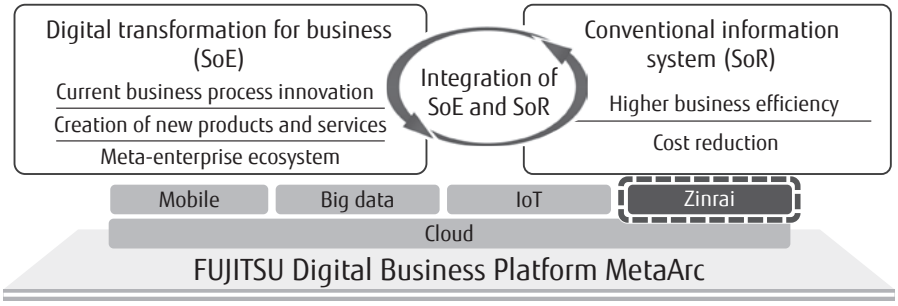

Figure 6
Implementation of Zinrai on MetaArc.

of AI to the businesses of customers.[2] This is an initiative that aims for the co-creation with customers of innovations through Proof of Concept (PoC) producing new technologies and ideas with customers, and Proof of Business (PoB) verifying customer businesses. Fujitsu proposes optimum AI use scenarios based on the technology of Zinrai, by carefully listening to customers about their business challenges and needs. For the provision of such services, Fujitsu established, on November 1, 2015, a new organization that oversees 200 people, including AI-related researchers and engineers, as well as data scientists called data curators. The role of this organization is to create AI markets. We believe that in order for customers to effectively use AI, it is important that we accurately learn about the content of their business and clarify the issues they face.

Promoting AI technology introduction processes in this way is what AI utilization consulting is about, but specifically, in the stage in which Zinrai-based ICT systems are introduced, this becomes the job of system engineers (hereafter, SE). Fujitsu's core competence is in its SE capabilities. We believe Fujitsu's strength to go beyond just proposing solutions as a consulting business, and to reside in our ability to translate the vision of our customers into actual systems that simply work for them.

7. Conclusion

This paper has described Fujitsu's AI initiative, which consists in Zinrai, our AI technology brand announced in November 2015, and the four technology fields that make up Zinrai (learning technology, sensory-media technology, cognitive technology, and mathematical technology).

Fujitsu's outlook on the future to be realized with these AI technologies is as follows. Recently, views expressing concern that people's jobs will be taken away by AI have been circulating in the media. Certainly, with the advent of AI, some of the jobs that people have held so far will inevitably be taken over by AI. However, when considering the future of AI, we must not forget that AI is here to support people. It is an unnoticed but reliable operative behind the scenes that enriches social life. Thanks to AI, people will be able to engage in more creative lines of work. And, through AI, we believe, new industries never envisioned before will come into existence, and through this, new types of jobs will be created one after the other. We are convinced that the new industries and services created in this way will usher in a future where people can lead richer and happier lives.

Fujitsu aims to promote the practical application of AI technology by furthering and supporting social acceptance of AI and solutions to ethical, legal and social issues (ELSI). This study was carried out in part as a collaboration with the National Institute of Informatics and Nagoya University.

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