Fujitsu's Approach to Its AI Business and Cutting-Edge Technologies

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New AI technologies and services based on them have developed at a fast pace in recent years, bringing major changes to businesses and our private lives. With more than 30 years of research in AI, Fujitsu addresses this major transitional era with FUJITSU Human Centric AI Zinrai, a solution that offers ICT with human perspectives at its heart. Zinrai integrates our cutting-edge technologies, such as machine learning, sensory media, knowledge technology, and mathematical techniques, to make ICT evolve in ways that are more human-friendly. This paper describes Zinrai from the viewpoints of software, services, infrastructure, and hardware. It also gives an account of the initiatives at Fujitsu for developing AI businesses.

1. Introduction

"Artificial intelligence (AI)," which was first named at a workshop held at Dartmouth College in 1956, has progressed and declined in several waves over the 60-year-plus period since then. Today, however, the third-generation boom is taking place. In fact, AI is now attracting much attention throughout the world with hardly a day going by in which no AI-related news appears. Furthermore, AI is starting to have a major impact not only on industry and society but also on the lives of individuals.

Based on the technology and knowledge cultivated for more than 30 years at Fujitsu Laboratories, Fujitsu announced FUJITSU Human Centric AI Zinrai as its AI technology brand in November 2015 and launched the Zinrai Platform Service in April 2017.

This issue describes Fujitsu's approach to AI from the perspectives of case studies, solutions, and cutting-edge technologies. It introduces examples of co-creation with customers using AI, overseas case studies involving AI, solutions applying AI technology, and cutting-edge technologies now being researched and developed as fundamental technologies for those solutions.

2. History of AI

The first-generation AI boom took place following the Dartmouth workshop mentioned above. However, as AI could only be used to solve simple "toy problems" at that time, this boom fizzled out, resulting in the first "AI winter."

The coming of the second-generation boom took place in the 1980s, a period that saw the launch of Japan's Fifth Generation Computer Project and the development and commercialization of expert systems by Fujitsu and others to support the business operations of many ICT enterprises. The AI in this era, however, could not reach the level at which a computer could learn and make decisions on its own, and in the end, it was more a period in which "humans provided computers with knowledge." In addition, managing the instillation of knowledge in computers is itself a difficult task for humans. This period, as a result, led to another AI winter leaving behind no great impact in terms of practical use.

On entering the 2010s, a new technology called "deep learning" in the field of machine learning began to attract attention, signaling the coming of yet another AI boom. Deep learning is the latest neural-network technology that models the mechanisms of the human brain. In conventional AI technology, humans need to give AI a clue or direction when attempting to identify some type of feature from a large amount of data. In contrast, deep learning makes it possible for computers

to acquire knowledge in an autonomous manner.

A number of factors can be cited in the development of deep learning, such as the spread of the Internet and big data, an ease of accessing massive volumes of data, an increase in computer processing power, and the evolution of machine-learning algorithms. This breakthrough in AI in which "machines acquire knowledge on their own," thereby exceeding the limits of conventional AI, is the third-generation AI boom now in progress.

3. State of AI in business

The application of AI technology in the real world has not been that spectacular compared with its application in the gaming industry. But, for consumers, voice-assisted functions are beginning to be embedded in smartphones showing that AI is starting to penetrate society. In addition, the robotic vacuum cleaner and other home appliances are starting to incorporate AI functions and new products such as AI speakers are beginning to appear.

However, as for AI in business, the 2018 Comprehensive Study of Artificial Intelligence Business conducted by the Fuji Chimera Research Institute found that only 10% of the 30,000 Japanese companies surveyed were "already using AI," "in the testing and trial stage," or "studying the feasibility of introducing AI." Nevertheless, the AI market in Japan is predicted to expand to 23 trillion yen by 2020 and 86 trillion yen by 2030.[1)]

In 2011, IBM's Watson beat out human players on the TV quiz program, "Jeopardy!," and IBM took this victory as an opportunity to expand the application of this system to business. In Japan, some startup companies took the lead in developing AI applications in 2015, and various ICT vendors declared their intent to enter the AI market in 2016. At first, the emphasis was on conducting proof of concept (PoC) demonstrations for evaluation purposes, but from 2017 on, leading companies have been introducing in earnest. Customers, for their part, seek clarification of the cost-effectiveness of introducing AI in their business operations, while ICT vendors are at the stage of searching for AI business that is greatly different from existing lines of business.

4. AI and market needs

To better respond to AI-related needs that have been expanding dramatically in recent years, Fujitsu announced in November 2015 that it was structuring the AI technologies that it had come to develop over the last 30 years under the brand name Zinrai.[2)] Since that announcement, Fujitsu went on to receive more than 2,000 inquiries (as of November 2018) about Zinrai from government and municipal offices as well as from customers in a variety of industrial fields. The results of analyzing and breaking down those inquiries are shown in **Figure 1**. These results revealed major needs in the following markets:

1) New user experience (UX) in ICT systems such as chatbots
2) Knowledge utilization to extract beneficial information from a massive amount of documents that have been accumulated within a company
3) Predictive detection and discovery of equipment

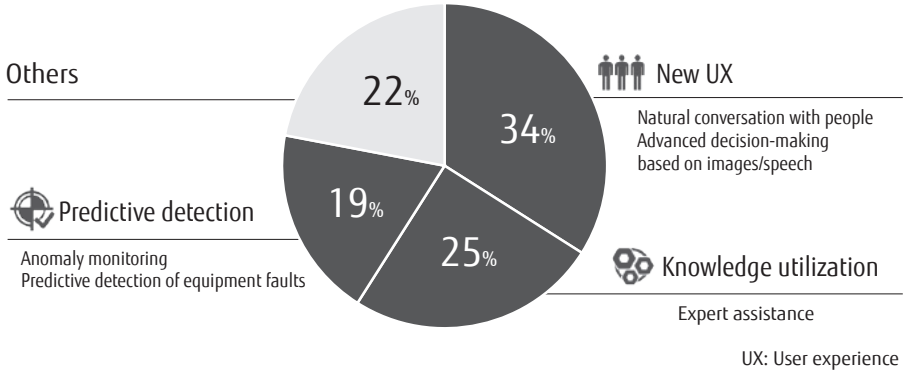

Figure 1
Breakdown of inquiries about Zinrai.

faults from sensor information in combination with IoT technology

A particular feature of these results is that there were many inquiries coming not from customers' ICT departments but directly from customers' individual business departments, i.e., lines of business (LOBs). This indicated that AI needs could vary greatly depending on business type or business tasks. Fujitsu is committed to providing an extensive lineup of products to meet the needs described above and to rolling out services that can respond to specific requirements in a flexible manner.

5. Approach to Zinrai software and services

To promote such diverse types of AI business, Fujitsu announced FUJITSU AI Solution Zinrai Platform Service in November 2016.[3] The Zinrai Platform Service provides AI functions corresponding to many customer needs and cutting-edge AI technologies based on field trials conducted with forward-looking customers, both in the form of web application programming interfaces (web-APIs).

The Zinrai Platform Service consists of the following two types of APIs (**Figure 2**):

- Type 1 provides basic and common AI functions such as image recognition and language processing.
- Type 2 combines building-block technologies by use case and incorporate Fujitsu business know-how to solve problems and improve business efficiency in accordance with the type of industry or business.

The purpose of the Zinrai Platform Service is to make it easy for customers to implement a wide variety of Fujitsu AI functions in their systems. A key feature here is the provision of AI functions in high demand by customers in the form of APIs, which makes it possible to respond promptly to the needs of customers who wish to introduce an AI system into their business operations. The Zinrai Platform Service also provides cutting-edge AI functions individually as basic APIs. As mentioned above, AI requirements in accordance with a customer's LOB can be quite diverse. With this in mind, the Zinrai Platform Service has been designed to deal flexibly with a customer's AI needs by incorporating multiple APIs with different functions, enabling new AI functions to be created.

In addition to the above, Fujitsu provides 17 offerings, based on customers' business problems, that

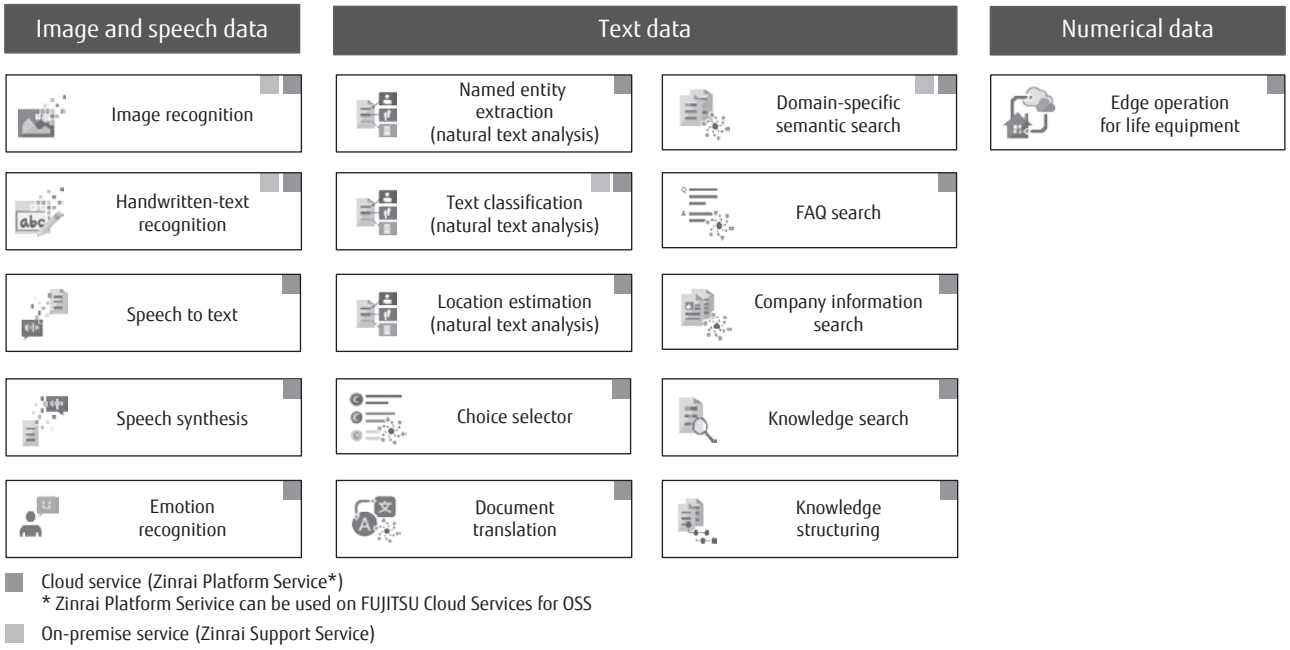

Figure 2
API list of Zinrai Platform Service.

highlight specific AI usage scenarios, the optimal Zinrai technologies and solutions for those scenarios, and the effects of their implementation.[4] Although many customers see a future in AI, they have yet to formulate specific AI usage scenarios. Knowing this to be the case, Fujitsu presents such customers with concrete images of how AI can be used in business in the form of offerings that can accelerate studies on introducing AI.

By providing a variety of measures as described above, Fujitsu is working to provide AI functions and introduce AI systems for customers wishing to deploy AI as quickly as possible to gain a strategic advantage in business.

6. Approach to Zinrai infrastructure and hardware

Fujitsu has come to develop and provide a variety of cutting-edge technologies and products in the field of high performance computing (HPC) including the supercomputer known as the "K computer."note) Today, Fujitsu is developing the following AI products incorporating technologies pioneered in HPC.

1) FUJITSU AI Solution Zinrai Deep Learning

Fujitsu offers Zinrai Deep Learning as a deep-learning platform service with processing performance in the world's fastest class. It is a hardware-based infrastructure as a service (IaaS) featuring top-class, high-speed learning by applying supercomputer parallel processing technology. Using this service while selecting APIs optimal for each customer can achieve high-speed, high-quality, AI-based systems.

2) Deep Learning Unit

Fujitsu is developing Deep Learning Unit (DLU), an AI-specific processor designed with proprietary architecture for deep learning. Featuring a radical low-power design, DLU aims to achieve a performance per watt figure approximately 10 times better than that of other companies.

3) Digital Annealer

Fujitsu began to provide Digital Annealer in Japan in May 2018. Inspired by quantum phenomena, it is a digital circuit that can solve combinatorial optimization problems at high speed. It features novel architecture that enables instantaneous solving of optimization problems that cannot be solved by conventional computers.

In addition to the above products, Fujitsu has been developing advanced HPC technologies to support AI research in Japan. To begin with, Fujitsu constructed the "Deep learning system," Japan's largest system dedicated to AI research, in collaboration with RIKEN.[5] It has also received an order from the National Institute of Advanced Industrial Science and Technology (AIST) for the AI Bridging Cloud Infrastructure (ABCI) supercomputer for AI applications, which is slated to become Japan's fastest supercomputer system.[6]

Fujitsu seeks to help its customers in achieving a business transformation and creating new business opportunities in a wide range of fields including finance, the life sciences, energy, and retail distribution by combining the total power of ICT including AI with the above AI-specific infrastructure services and hardware products.

7. Approach to AI business

Fujitsu has built up much industry and business knowledge to date through its work in system integration for customers in diverse business fields. Today, it is applying this knowledge to the Zinrai Platform Service. In this way, Fujitsu aims to grasp LOB needs and provide AI services that can truly contribute to its customers' business operations. Fujitsu has also been a manufacturer providing cutting-edge hardware products that can provide value in the form of enhanced AI services.

As a result, Fujitsu's system engineers (SEs), who up to now have been busy constructing systems of record (SoRs), are now engaged in constructing not just systems of engagement (SoEs) but also in providing services that leverage Zinrai Platform Service APIs and hardware functions such as Zinrai Deep Learning. The goal is to create AI solutions that can realize digital innovation in customer businesses. Zinrai Platform Service APIs are explained in the paper "Zinrai Platform Service to Accelerate Digital Innovations for Customer Businesses" in this issue. Furthermore, pioneering case studies of such digital innovation are introduced in "Fujitsu's Deep Leaning Technology that Enables Smart City Monitoring" in this issue (**Figure 3**).

In addition, through co-creation with customers, not by itself alone, Fujitsu is working to create new

note) "K computer" is a supercomputer developed by RIKEN and Fujitsu.

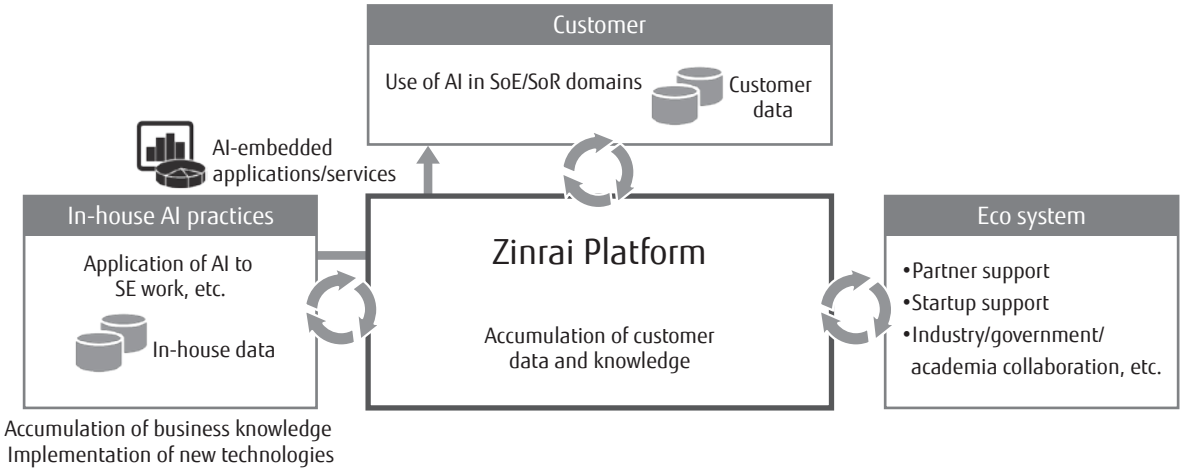

Figure 3
Fujitsu's AI rollout strategy.

AI services in conjunction with the customers' expert knowledge. Every company's LOB is rapidly being transformed by ICT, and AI is expected to be a key factor in creating advanced services. As it stands now, however, the data that a company possesses is not being utilized as well as it can be.

Fujitsu's approach to this situation is to provide cutting-edge AI technologies to companies that wish to utilize their in-house data through AI and to combine that customer data with specialized technologies in the industrial domain. In this way, Fujitsu hopes to create synergy between both parties and create previously unheard-of services. The "Examples Leveraging AI Technology" section of this issue introduces new services developed through co-creation with customers.

Studies of AI are progressing at such forward-looking companies, but most customers are anxious about introducing AI since there are still many unknowns about its cost-effectiveness. The AI market has only recently appeared, and case studies of deploying AI in business operations are still few. Consequently, for many customers, the effects of introducing AI are still hard to gauge. For this reason, Fujitsu itself conducts in-house trials of new solutions using Zinrai to extract problems and clarify the cost-effectiveness of those solutions. This approach enables Fujitsu to advise customers of the cost burden of AI deployment while making a persuasive case that the advantages of deploying AI would outweigh that burden.

Additionally, open innovation is essential to the development of new technologies in the AI era. To begin with, Fujitsu is collaborating with high-level researchers in industry, government, and academia in Japan and abroad such as at the RIKEN AIP-FUJITSU Collaboration Center[7] of the RIKEN Center for Advanced Intelligence Project and at National Institute for Research in Information and Automation (*Institut National de Recherche en Informatique et en Automatique*: INRIA)[8] in France. Several of these collaborative projects are introduced in the "Cutting-edge Technologies that Support Zinrai" section of this issue. Fujitsu pursues these collaborative efforts not just for its own AI development or AI service provision since it considers the creation of a Zinrai ecosystem that includes collaboration with startups[9] and partner support to be an important part of open innovation. Fujitsu seeks to speed up the provision of new and attractive services by collaborating with startups in this way. It will also establish measures within the Zinrai ecosystem to make it easier for customers to investigate the use and deployment of Zinrai.

8. Conclusion

This paper described Fujitsu's approach to AI business, highlighting its AI services including the Zinrai Platform Service, AI-specific hardware including Zinrai Deep Learning, and AI-based business systems.

When first introducing Zinrai in the January 2017 issue of this journal,[10] its application to business was still in its infancy. However, in about two years since

then, AI business at Fujitsu has entered a stage of concrete and steady progress enabling it to make substantial contributions to the business pursuits of its customers. However, as the concrete application of AI to business progresses, the handling of added value created from customer data by AI technology has become a sensitive issue and a frequent topic of discussion. In response to this new business situation not observed in conventional ICT business, Fujitsu considers co-creation that can produce a win-win situation with customers to be a major premise of its AI activities.

Fujitsu, as an AI service provider that has the utmost respect for the ideas put forth by its customers, the data owners, aims to foster innovation by combining the technologies and knowledge of both parties and to create and expand new business ventures together.

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