Zinrai Platform Service to Accelerate Digital Innovations for Customer Businesses

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With Zinrai Platform Service, Fujitsu offers sensing and recognition, knowledge processing, and decision and support functions covering each major AI element technology, as well as various other functions and knowledge that customers can combine as suitable for their business needs, with the goal of facilitating AI use by customers. Functions such as image and voice recognition, and knowledge discovery from text-based information are provided as application programming interfaces (APIs). These can be used on their own, but their application requires some effort, such as data preparation and parameter tuning. To cope with this problem, the APIs provide functions and configurations ready-made and tuned to solve particular issues. They are designed based on knowledge and functions that allow customers to combine component technologies according to their use scenarios and facilitate easy introduction of AI to their businesses. This supports the adoption of AI by enterprises. This paper presents the major functions of Zinrai Platform Service and describes its characteristics. It also explains the main concepts behind the platform feature configuration and discusses, based on some application cases, the value of this service for businesses.

1. Introduction

In recent years, AI technology has made great strides, and it is now being used for consumer applications such as smartphone apps, web search, and other information services. Meanwhile, companies are also increasingly looking to AI for improving productivity at various sites, such as product defect inspections and inventory optimization based on demand forecasting.

In response to the growing AI needs of enterprises, Fujitsu began offering Zinrai Platform Service[1)], which implements AI functions as cloud services, from April 2017, and has been gradually expanding this service ever since.

This paper presents major functions of Zinrai Platform Service and describes its characteristics. It also explains the main concepts behind the platform feature configuration and discusses, based on application cases, the value of this service for businesses.

2. Overview of Zinrai Platform Service

Fujitsu has been developing AI-related knowledge and technologies for over 30 years since the 1980s under the leadership of Fujitsu Laboratories. In November 2015, these technologies were organized into a system and announced under the brand name of FUJITSU Human Centric AI Zinrai.[2)]

The distinguishing characteristic of this technology system is that it is structured by linking the diverse AI functions of sensing and recognition, knowledge processing, and decision and support, according to the flow of data. Taking a page from human intelligence, AI can be regarded as realizing intelligence partly by enlisting machines and software. Most recent AI initiatives, especially those belonging to the third AI boom represented by deep learning, involve learning features from the data beforehand, and supporting judgment and actions based thereupon. The three function groups of sensing and recognition, knowledge processing, and decision and support are described below.

The first category, sensing and recognition, consists of functions that collect image and voice data by sensing company sites and the society in which people act, and perceives and recognizes such data as meaningful information for humans and society. The second

category, knowledge processing, consists of functions that extract basic elements for understanding information, such as persons' names and place names, extract relationships between basic elements, such as which company a person belongs to, and discover patterns from text-based information such as web pages and office documents. The third category, decision and support, consists of functions that support human judgment while referencing the information obtained by the functions of the above categories.

These three function groups may be used each on its own. However, to realize complex objectives, advanced functions can be realized through the mutual use and combination of information obtained by the respective function groups.

Zinrai Platform Service implements these three function groups as services that can be offered either in the cloud or on-premises. This allows users to freely select the functions that they need and combine them. For example, multiple AI functions can be flexibly configured by calling up AI as needed from existing systems and using web application programming interface (web-API) combinations. Further, the use of AI requires the preliminary collection of data, its preparation, and the creation of learning models. For that purpose, we provide also wide range of peripheral functions ranging from on-premise all the way to the edge to allow users to easily utilize AI according to their respective purposes (**Figure 1**).

For example, in the case of an image recognition API, inputting an image and calling up a web-API makes it possible to acquire the recognition result as a character string. For this type of recognition, we use the high-speed inference function of deep learning, which can be deployed in a cloud environment, allowing users to easily use component functions of AI by calling services without having to be aware of details such as infrastructure. Moreover, APIs prepared in advanced for the configuration of recognition models and parameters for specific tasks are also available, further simplifying the introduction of AI by corporate users for specific tasks.

Currently, Zinrai Platform Service provides more than 16 APIs, which are classified as "image and speech data," "text data," and "numerical data" based on the type of source data (**Figure 2**).

Three functions are introduced in the following sections, with examples.

3. Sensing and recognition functions

These functions receive data from the real world such as camera images and microphone recorded

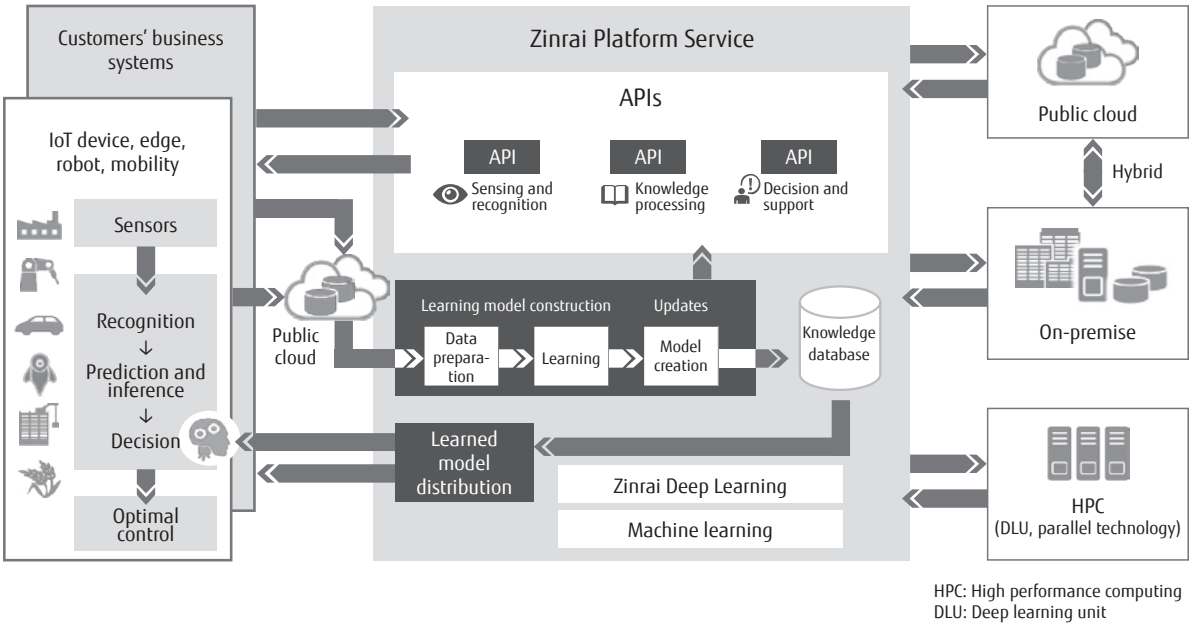

Figure 1
Zinrai Platform Service.

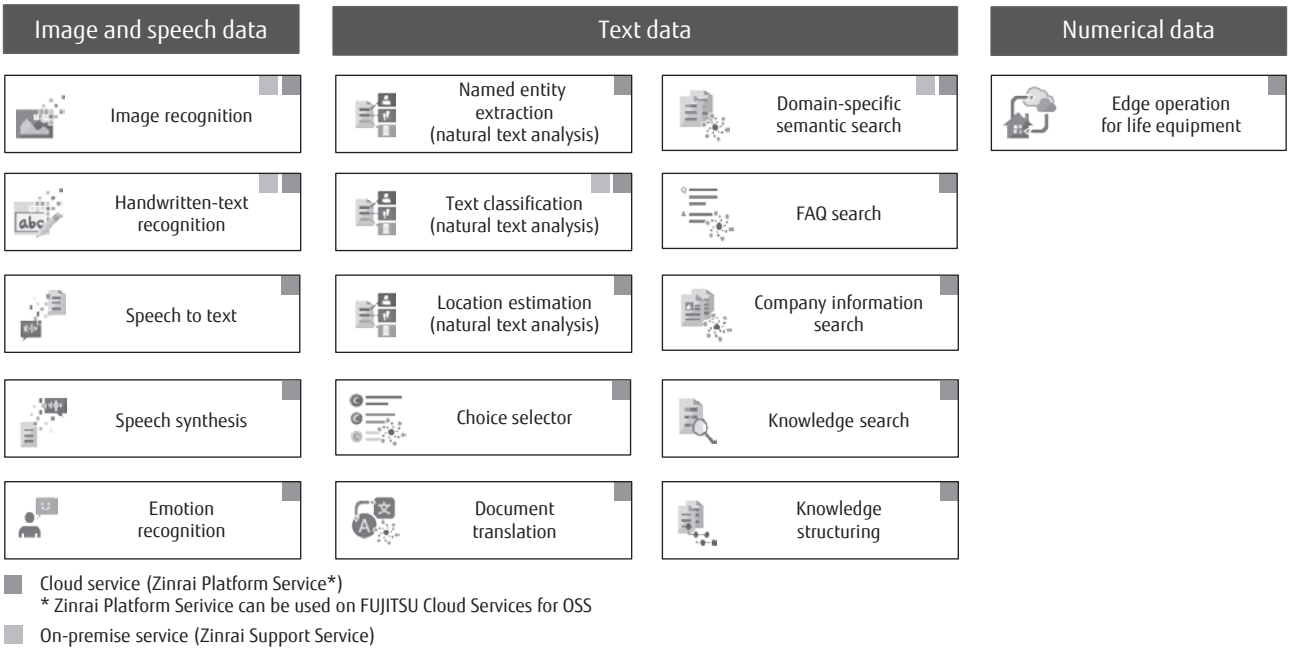

Figure 2
API list of Zinrai Platform Service.

voices, and convert them into meaningful information for people. Major functions include image processing, voice processing, emotion/situation recognition, and the like.

A handwritten string recognition API is described below as a specific example.

1) Background

At present, a business process outsourcing (BPO) business that digitizes handwritten characters written on a form called data input service, exists. However, because it involves many aspects that depend on humans, it is costly and takes time. One possible solution was optical character recognition/reader (OCR), which scans documents, converts them into images, and automates data entry. In the case of the kanji and katakana characters used in Japanese, however, many characters are divided into parts, and recognition accuracy was insufficient.

2) Overview of function

The handwritten string recognition API recognizes handwritten characters in images and outputs character string information using a character string recognition model and a language model. To reduce the number of errors in recognizing breaks between characters, which is a problem in conventional handwritten character recognition, recognition regions are delimited by the insertion of a special determiner called a non-character. Language models can be used that indicate which words are most likely to follow other words, thus enabling adjustments in order to achieve more natural word choices and sentences, and thereby improving recognition accuracy for character strings. Through the use of these technologies, we have achieved recognition accuracy that exceeds that of the existing technology in benchmark using a database for handwritten text recognition research.

3) Application case

These functions were applied to an insurance company's payment procedures. For example, insurance claim forms and medical certificates required for insurance claim procedures for accidents include fields where claimants fill in addresses, names, verification items, and so on, by handwriting. For the character strings of addresses and names, specifically-located character occurrence probabilities learned from the above-described language models make high-accuracy recognition possible. As a result, it was possible to dramatically shorten the time required for digitizing handwritten content in documents.

In sensing and recognition functions, deep

learning is used for many functions as a basic technology for recognition. Deep learning is capable of high-speed processing through the use of graphics processing units (GPUs). However, in large-scale learning, it is necessary to run multiple GPUs in parallel, and performance depends on the scale of parallel operation. By optimizing parallel processing of deep learning, Fujitsu has increased processing speed by a factor of ten or more, thereby realizing the world's highest class of execution environment.

Current applications often recognize objects of a predetermined category from camera images such as smartphones. Going forward, as company-specific tasks such as product inspection on production lines are increasing, we will further strengthen APIs to allow the easy construction of individualized recognition models and solutions tailored to the distinct needs of each business.

4. Knowledge processing functions

These are functions that extract useful information from documents, such as web pages and printed documents. With this information, computers can understand the content of the documents, such as the names of persons and places, the relationships between things or between things and events, and so on. Major such functions include natural language processing, knowledge processing and discovery, and pattern discovery.

As a specific example, a natural text analysis-related API is described below.

1) Background

In recent years, trends and tastes analyzed from content posted on social media such as Twitter have begun being used for marketing and other purposes. However, since information on social media is atypical and there is little contextual information, it is not easy to acquire useful information such as place information or authenticity from such sources.

2) Overview of function

Zinrai has three APIs related to natural text analysis: named entity extraction, text classification, and location estimation. The named entity extraction API extracts persons' names and place names from the context of sentences and outputs them with tags. The text classification API also assigns labels and certainty scores to sentences that match the topic(s) targeted for classification. The location estimation API estimates place names, addresses, and coordinates (longitude and latitude) from the sentence information of the input text by using place name databases and estimation rules.

3) Application case

The text classification API for natural text analysis can be applied to inquiries collected by call centers to gain an accurate understanding of communicated content through the tabulation of text input by operators describing the inquiries.

As call centers receive many inquiries, an overall grasp of all communicated content is beyond the reach of any given human operator. Further, if classification of inquiries were to be done manually, personal differences of judgment among the human operators would also be an issue.

Text classification API can be applied to this problem. For example, in the case of inquiries and complaints from customers received by a call center or website, labels can be attached automatically while referencing a learning model based on sample responses by experienced call center operators. In this way, automation of classification at a level equivalent to that of highly skilled operators can be achieved (**Figure 3**).

Use of this API makes it possible to classify and organize various information at a company and to shorten the time spent sorting large amounts of data used in business analysis. Further, for tasks whose execution depends on the skill of the operator, this function makes it possible to achieve a uniform level of accuracy on a par with that of skilled operators.

In natural language processing, the capacity to accommodate the variations in expression that characterize natural languages is important. To this end, a large number of usage examples (corpus) are collected and variations can then be automatically learned by machine learning. Fujitsu possesses the learning methods and a huge corpus cultivated over many years of corporate practice, and based on this, we can analyze text with high accuracy.

Based on this basic technology, we will strengthen applied technologies to deal with special terms and language used in fields such as medicine and manufacturing, and promote the application of natural language processing according to each company's situation.

5. Decision and support functions

These functions support decision-making and action by presenting appropriate and accurate information.

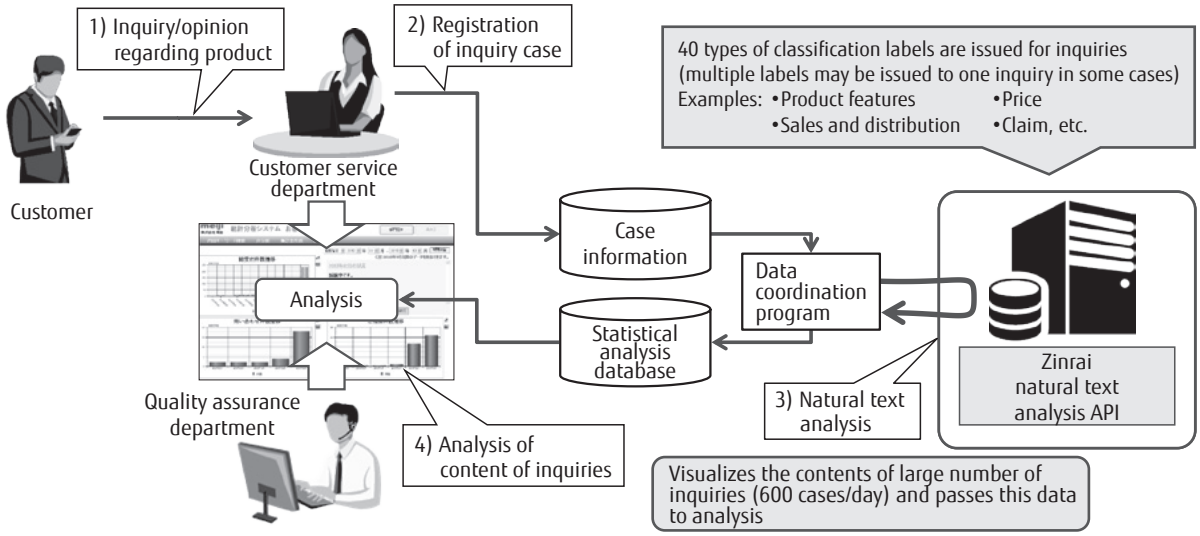

Figure 3
Natural text analysis.

Major functions include inference and planning, prediction and optimization, and dialogue and recommendation.

In the following, topological data analysis (TDA) for anomaly detection is described as a specific example.

TDA is one of various data analysis methods, and Fujitsu Laboratories has developed proprietary technology that applies this method to time series data (see "Topological Data Analysis and Its Application to Time-Series Data Analysis" in this issue). In fault diagnosis and material degradation prediction, many things cannot be classified by conventional statistical methods. To remedy this, a function for judging when diagnosis is difficult for humans that is based on sophisticated mathematical techniques rather than human empirical rules is required. As an example of anomaly detection using TDA, the estimation of the degree of damage inside bridges is introduced below.

1) Background

Many of the bridges built during Japan's period of high economic growth are deteriorating. The rapid increase in the amount of work required to maintain them, the rising maintenance costs, and the shortage of engineers are becoming issues that affect society. Hence, the application of ICT to the maintenance of social infrastructure such as bridges is being looked to as a solution.

2) Overview of function

Using complicated time series vibration data obtained from sensors installed on IoT equipment and the like, geometric characteristics can be extracted and learned. We have developed technology that, by doing so, allows quantification of the degree of anomaly indicating the difference from the value when the state of the structure or equipment is sound, and the degree of change indicating sudden changes in state. With these quantities, anomalies and characteristic changes can be automatically detected (**Figure 4**). Vibration data is expressed in a space different from the time series by conversion using chaos theory, classification is done using the geometric characteristics of the space, and the degree of anomaly and the degree of change are calculated accordingly.

3) Application case

Normally, the inspection of bridges consists mainly of visual inspection of damage to the structure. However, visual inspections can detect only anomalies at the surface of the structure and they cannot yield information on the degree of internal damage, which is a problem.

As a solution, we developed technology that acquires data from sensors installed on the surface of the bridge and estimates the internal state by mathematical analysis. Since this technology can detect the occurrence of internal strain, it allows the detection of anomalies at an early stage when the damage cannot be visually observed from the outside, and thus it can

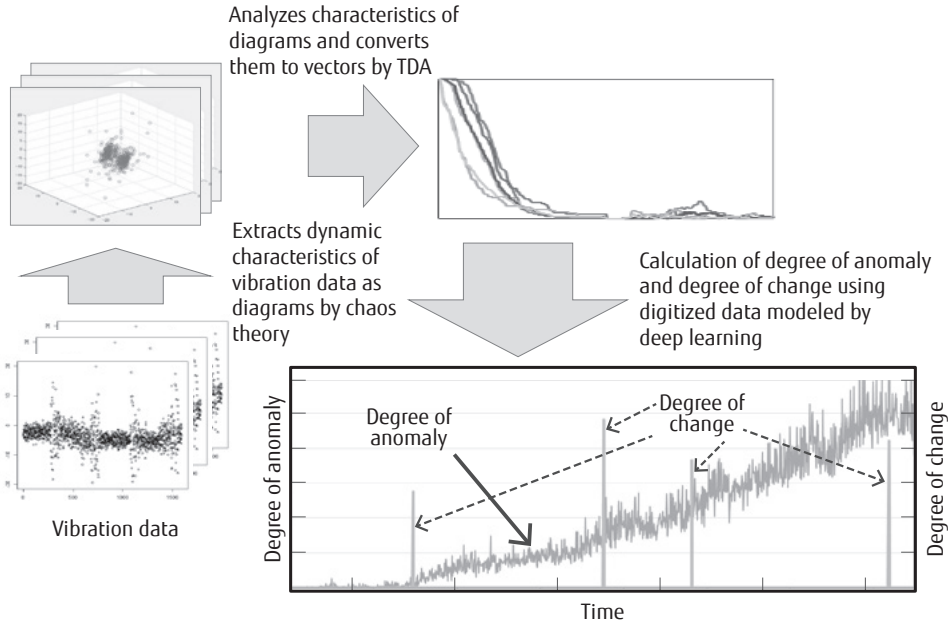

Figure 4
TDA anomaly detection.

contribute to early measures against damage.

For decision and support functions, mathematical techniques such as TDA mentioned above are regarded as important. In traditional decision and support, thresholds obtained from experience and simple statistics were often used as criteria for judgment. However, fault diagnosis and abnormal value determination required for the manufacturing industry and social infrastructure are often not classifiable by simple statistical processing. Therefore, mathematical technology that makes use of sophisticated mathematics like TDA is needed.

At present, a data scientist with mathematical knowledge and business insight determines which mathematical approach is applicable to which case. However, methods that apply TDA to the initial analysis to investigate the effectiveness of techniques at an early stage and evaluate multiple analysis methods concurrently through automation have also been developed. Next, we will incorporate such analytical support on the Zinrai platform to allow data scientist to concentrate on the high-level tasks to be solved, thereby further accelerating analysis.

6. Graph structure and edge cooperation

With the recent spread of fields that utilize AI, new issues have become apparent. One such issue is increasing data complexity, and another one is the diversification and growing scale of data sources. This section describes new technologies that deal with these issues.

The use of AI in fields such as medicine, chemistry, and finance must deal with the complexity of the data structures to be handled and inter-data relationships. In doing so, the graph structure, which can express various data, is particularly powerful. For example, relations of friendship in social media, the structure of compounds, and relationships between gene mutations and diseases can be expressed by graph structures. In the dawning big data era, such graph structures can be seen everywhere, and demand for graph structure analysis is increasing day by day. In response, Fujitsu Laboratories developed a unique technology called Deep Tensor that deals with graph structures.[3)]

Deep Tensor is a deep learning method that allows us to treat graph structures as inputs, whereas conventional deep learning has treated image and voice data as input data. The graph structure is a data structure that represents the relationship between people, objects, and so on. The use of Deep Tensor makes it possible to classify graph structures used as input into specific classes and to analyze continuous values

recursively. In the future, we plan to commercialize this Deep Tensor technology and further expand it to extract knowledge from data more diverse and complicated than ever before.

Meanwhile, not only will the data become more complex, but it will grow in scale as the types of devices that are their source increase. The type of devices is expanding from PCs and smartphones to sensors, and the places where these devices operate are likewise expanding beyond locations with people to many places without people. As the data gathered from such devices becomes enormous, more advanced AI functions will be required.

To allow quick obtainment of results from gigantic systems, analysis and decision-making capabilities will need to be allocated in part to devices. In other words, edge cooperation that divides AI functions between the "edge" of the network where the devices exist and the "center" where the servers exist will be required. This is expected to contribute to load reduction in terms of network usage and computation processing and to decision-making speed, and represents an area that will likely experience significant growth in the future.

Going forward, we plan to offer these technologies as part of Zinrai Platform Service.

7. Conclusion

This paper described the major functions of Zinrai Platform Service and the technologies they use.

As AI application areas expand further, Fujitsu will provide a variety of solutions based on a variety of data and AI element technologies whose development is spearheaded by Fujitsu Laboratories. At the same time, we will accelerate digital innovation for our customers' businesses by providing high added value through the Zinrai platform based on Fujitsu's wealth of knowledge of industries and business operations. In addition, we will continue to expand and enrich Zinrai Platform Service on the strength of Fujitsu's unique AI technology capabilities to further strengthen our value proposition to customers.

References

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3) Fujitsu Laboratories: Fujitsu Technology to Elicit New Insights from Graph Data that Expresses Ties between People and Things. *http://www.fujitsu.com/global/about/resources/news/press-releases/2016/1020-01.html*

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