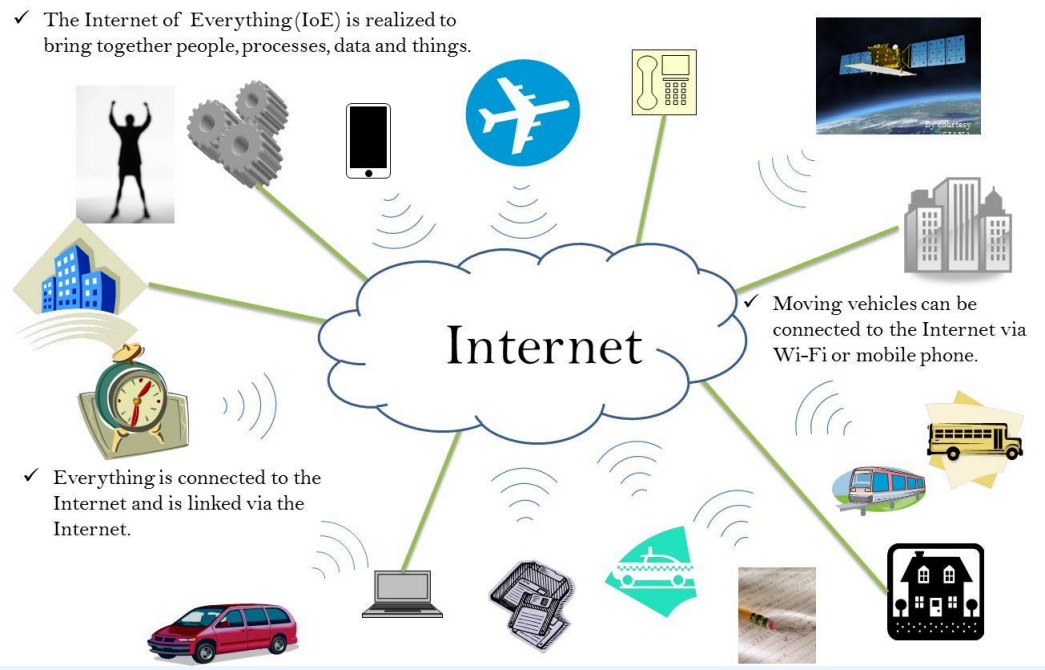
## Before Reading Further

Recently, we often hear the words "artificial intelligence," "big data" and "the IoT"[1] in the news. But just what do these words mean? These words are explained in detail in Section 1 of Chapter 2, so rough ideas of the words are first described here.

A brief diagram of the IoT is shown in Figure 1-1-1.

■ Figure 1-1-1 / Schematic overview of the IoT




Source: MEXT

In the IoT, every physical object is connected to the Internet. Conventionally, we access the Internet by operating a computer. But these days, things we use every day, such as consumer electronics and automobiles, are directly connected to the Internet.

For example, there are HVAC systems that can be connected to the Internet for remote control by smartphone. On a cold day, we can return to a comfortably heated room if we turn on the HVAC system at home by smartphone before leaving our office. If moving vehicles communicate online with each other, there will be fewer traffic accidents and less congestion. In the age of the IoT, things around us and even in outer space are connected to the Internet, to enable their condition to be monitored, devices to be remotely controlled, and communication to be done between physical objects. Various things that were once

1 The Internet of things

impossible have become possible, making our daily lives more convenient.

Large quantities of data that are sent out by sensors installed in the devices we use on a daily basis are stored on the Internet. Such data, known as big data, can be used in various ways, and the analysis of such data helps to generate new value and knowledge. Increases in the number of Internet users and devices for connecting to the Internet, the advancement of Internet technology, the enhancement of computer processing power and the realization of the IoT have made it possible to extract undiscovered knowledge and insights from an enormous quantity of digital data for use in research and business.

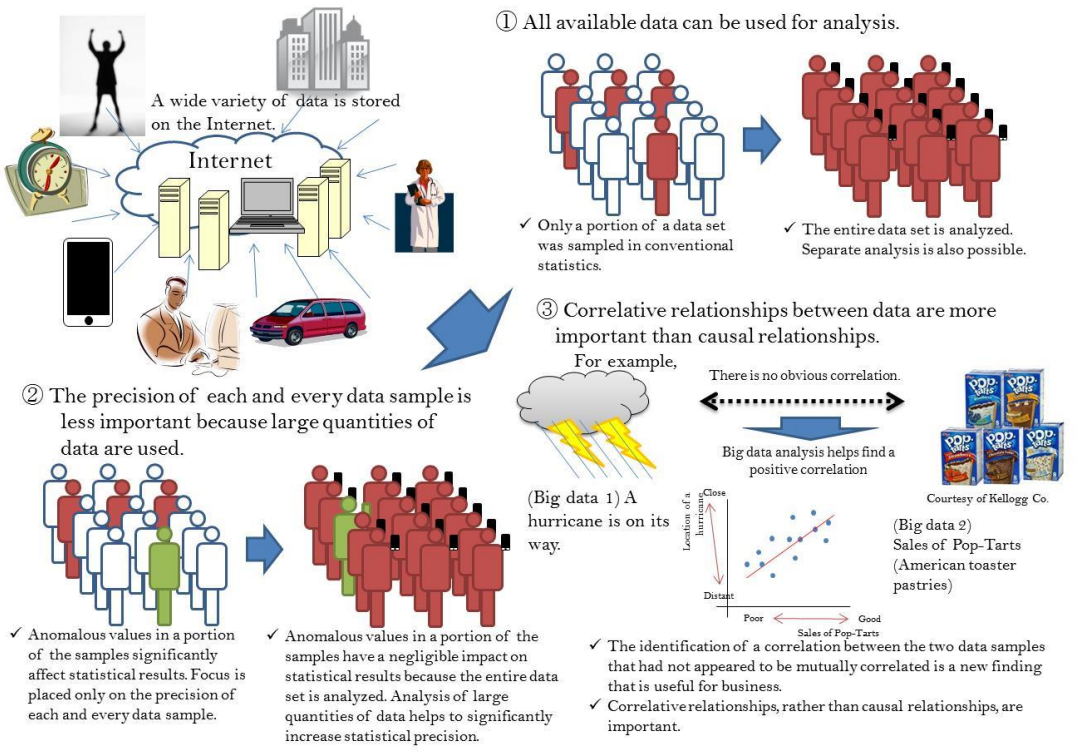
Big data consist of diverse types of data. Data are roughly divided into two types. There is "virtual data," which is generated on websites and through SNS[1] and other activities within the Internet space. And there is "real data," which is measured by sensors and which includes health data, vehicle travel data, the operational status of appliances and facilities, and the real-world activities of individuals and businesses[2].

Virtual data is information that people put on the Internet when they send e-mails or do Web searches by using computers, smartphones or other cell phones. Real data includes data on the following: health information, such as diagnoses and the results of medical checkups given by medical institutions; vehicle travel data and location information collected by GPS devices; personal usage history of transit smart cards; physical quantities, such as temperatures and pressures collected by sensors embedded in devices[3]; and personal purchase history recorded via membership cards.

For example, Google Inc., the American technology company, succeeded in predicting an epidemic of a novel flu strain on a real-time basis and earlier than the government of U.S.A. without accessing laboratory data or contacting medical institutions. To predict that epidemic, Google Inc. analyzed search data from the Internet as big data[4]. By analyzing vast amounts of weather data and customers' purchasing data, Wal-Mart Stores, Inc., the American retail corporation, found that when a hurricane was forecast to hit an area, the popular Pop-Tarts toaster pastries sold well there. After finding this unintuitive correlation, Wal-Mart stocked Pop-Tarts next to hurricane disaster supplies when a hurricane was expected, and Pop-Tarts sales increased[5].

1 Social networking services
2 Documents for the sixth meeting of the New Industrial Structure Committee, the Industrial Structure Council, February 29, 2016
3 The creation of data can be defined as a process in which phenomena are quantified for the aggregation and analysis of data.
4 Viktor Mayer-Schoenberger and Kenneth Cukier. Big Data: A Revolution That Will Transform How We Live, Work, and Think. May 2013.
5 Viktor Mayer-Schoenberger and Kenneth Cukier. Big Data: A Revolution That Will Transform How We Live, Work, and Think. May 2013.

■ Figure 1-1-2 / Characteristics of big data



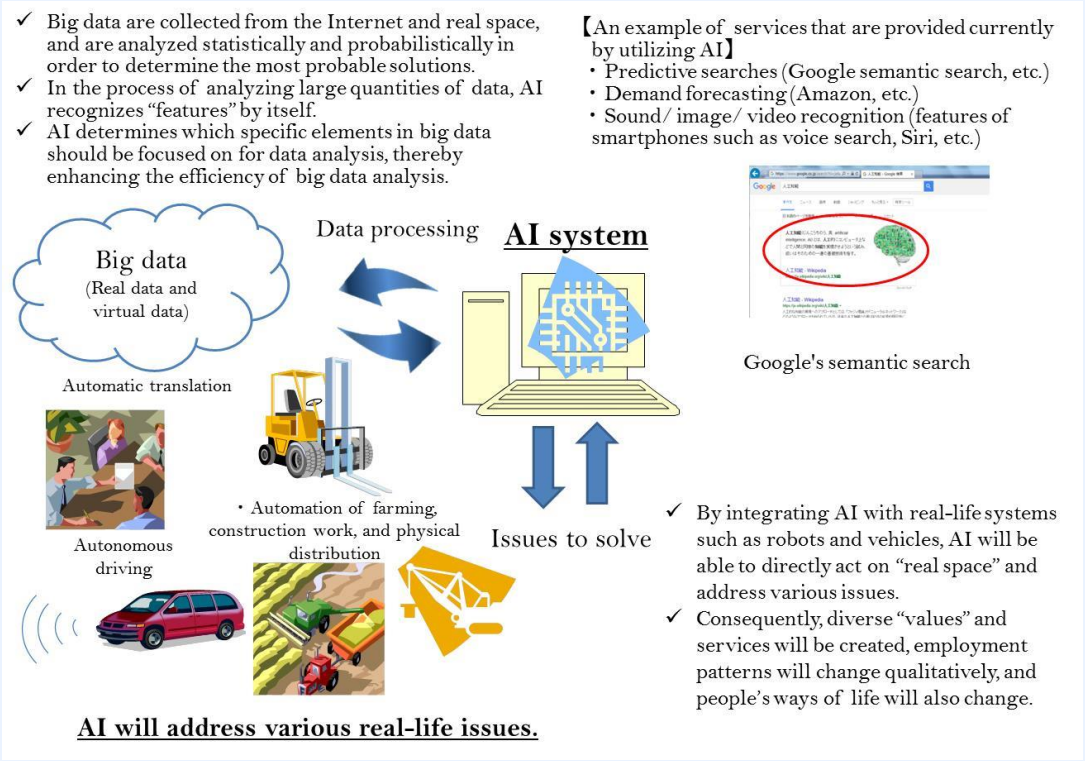

Source: MEXT

Large quantities of data have been used for research in astronomy and genome science, as well as in cohort studies[1]. These data were collected and analyzed for specific research purposes[2]. The big data of today differs from the data used for such purposes in that 1) all available data can be used for analysis, 2) the precision of each and every data sample is less significant because large quantities of data are used and 3) correlative relationships between data are more important than causal relationships. Currently, a wide variety of data, including unstructured or disorganized data, is used and combined to create new "value" and obtain new insights (Figure 1-1-2).

These days, major breakthroughs in artificial intelligence (AI) are expected. A schematic overview of AI is shown in Figure 1-1-3.

1 Long-term follow-up survey of a specific group of people (i.e., a cohort).
2 Viktor Mayer-Schoenberger and Kenneth Cukier. Big Data: A Revolution That Will Transform How We Live, Work, and Think. May 2013.

■ Figure 1-1-3 / Schematic overview of artificial intelligence (AI)




Source: MEXT

Artificial intelligence is already being used in our everyday lives and has made novel services possible. These services include "semantic searches" that are incorporated in Google search engines so as to automatically display results relevant to key words, and concierge services offered by Siri installed in iPhones and other Apple products. The term artificial intelligence may remind many people of robots that understand situations and intentions. However, such robots do not exist now. There is no single definition of artificial intelligence that experts unanimously agree on.

Artificial intelligence, which is expected to make substantial progress, refers to programs that conduct statistical and probabilistic analyses of large quantities of data kept on the Internet in order to arrive at the most probable solutions. For example, when artificial intelligence is used for language translation, the intelligence chooses the most likely translation by analyzing a wealth of text, without giving consideration to the grammatical structures or meanings of the sentences.

Artificial intelligence is expected to advance further because a new technology called deep learning has made it possible for AI to learn "features"[1]. Robots are expected to be increasing used as a way for artificial intelligence to access the real world. Robots installed with artificial intelligence will be able to perform various real-life jobs and will be used for various purposes.

1 "Features" refers to specific elements contained in data that are to be focused on when the data are analyzed. Features were provided to AI by humans in the past, but now deep learning helps AI to create features for some important problems, such as image recognition and sound recognition.

Column 1-1

## What is a super smart society?

The topic of the White Paper on Science and Technology 2016 is a super smart society. A super smart society is a notion defined in the 5th Science and Technology Basic Plan. The Science and Technology Basic Plans are formulated by the national government pursuant to provisions in the Science and Technology Basic Law (Act No. 130 of 1995). Each of these plans is a five-year plan for ensuring the comprehensive and systematic implementation of measures that need to be taken by the government to achieve a ten-year goal through the promotion of science and technology[1]. The 5th Science and Technology Basic Plan, covering the five years from 2016, was approved in a Cabinet meeting on January 22, 2016.

The 5th Science and Technology Basic Plan has four pillars, one of which is "acting to create new value for the development of future industry and social transformation." Part of these efforts aim at the realization of a super smart society before the rest of the world. The rapid advancement of information and communication technology has resulted in tremendous changes in the process of creating new value and knowledge, industrial structures, and our society and economy. Additionally, the world has been seeing a dramatic expansion in the use of cyberspace and networking. In light of these facts, the whole nation needs to share a vision of a super smart society as Japan's ideal future society, where efforts are made to proactively take advantage of cyberspace in order to continuously create new value and services as well as to ensure an affluent citizenry.


**The Concept of Society 5.0**

Source: Cabinet Office

The 5th Science and Technology Basic Plan defines a super smart society as "a society where the various needs of society are finely differentiated and met by providing the necessary products and services in the required amounts to the people who need them when they need them, and in which all the people can receive high-quality services and live comfortable, vigorous lives that makes allowances for their various differences, such as in age, sex, region and language." The Basic Plan calls for a series of initiatives geared toward realizing a super smart society, and these initiatives are being deepened and intensively promoted under the Society 5.0 program. According to the above-mentioned plan, the name Society 5.0 indicates "a new society created by transformations led by scientific and technological innovation, following the stages of hunter-gatherer society, agricultural society, industrial society and information society." The Basic Plan calls for a series of initiatives geared toward realizing a super smart society, and these initiatives are being deepened and intensively promoted under the Society 5.0 program. According to the above mentioned plan, the name Society 5.0 indicates "a new society created by transformations led by scientific and technological innovation, following the stages of hunter-gatherer society, agricultural society, industrial society and information society."

To realize a super smart society, Society 5.0 will form a super smart society service platform that creates value through the collaboration and coordination of many different systems, that standardizes data formats and the like, and that fosters necessary human resources. The Basic Plan goes on to state that, in order to make Japan competitive among the super smart societies of the world, Japan will strengthen technologies for cybersecurity, IoT system development, big data analysis and artificial intelligence, in order to strategically strengthen the internationalization of standards, intellectual property rights and basic technologies.

1 The results produced on the basis of the Science and Technology Basic Law in the past 20 years were summarized in the White Paper on Science and Technology 2015, subtitled "Toward a Country Making Innovation Happen in Society and Economy Using Science and Technology: Outcomes of 20 Years of the Science and Technology Basic Law and Future Science, Technology and Innovation".