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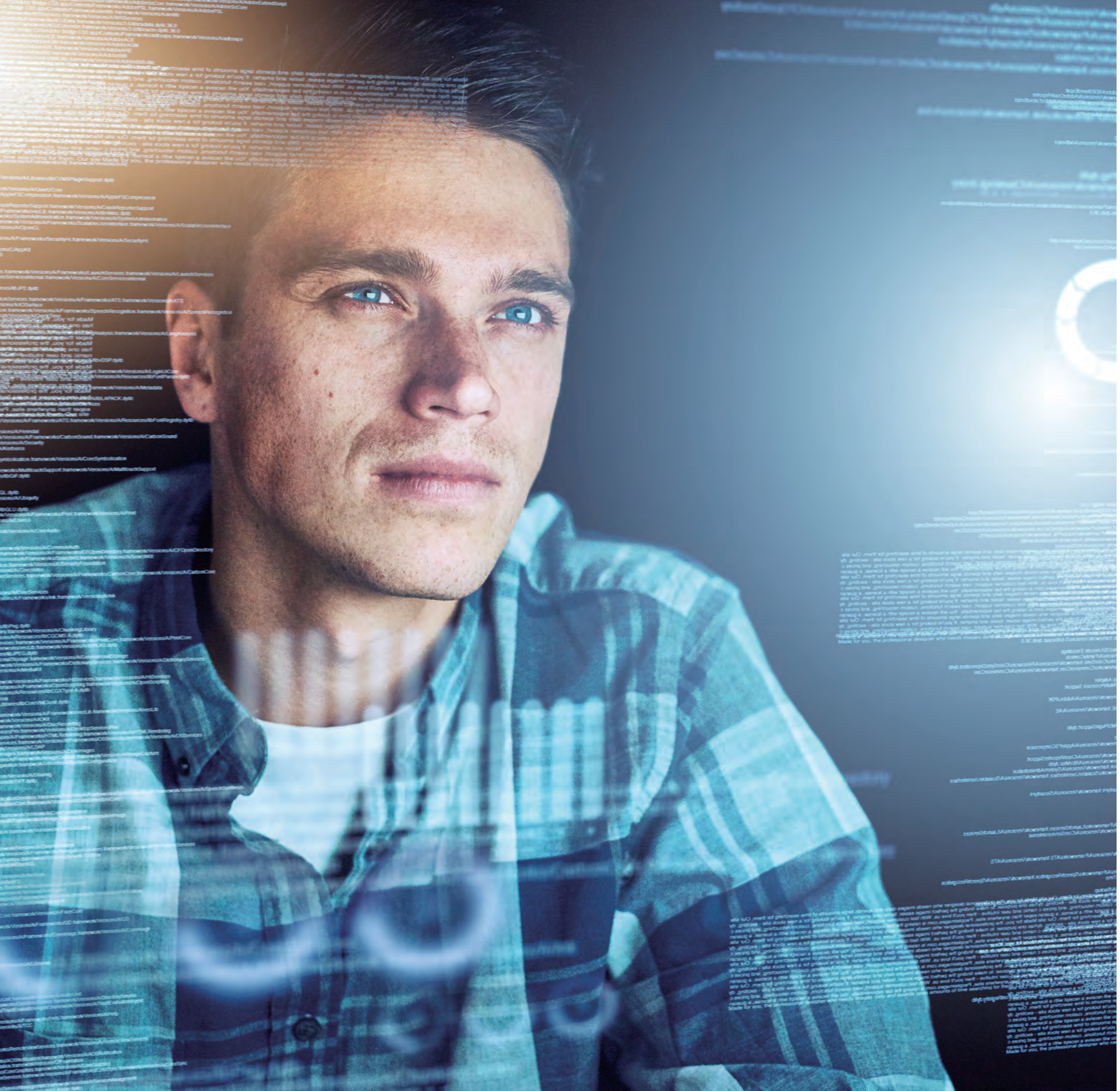
NTT DATA Technology Foresight 2019

LOOKING AHEAD: Technology Trends Driving Business Innovation



Looking ahead: Technology trends driving business innovation.

Digitization has placed society at the beginning of the next social revolution. The constant innovation in technology will continue to drive social structures toward the future, transforming existing business models and bringing them to new levels.

To make optimal business decisions, it is critical for leaders to identify and understand future changes and to determine the best course for sustainability.

At NTT DATA, we continually investigate advanced technologies and social trends that we believe will impact businesses over the next three to ten years, and we publish these findings on an annual basis for the benefit of our clients.

NTT DATA
Technology
Foresight

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Information Society Trends

Societal trends impacting people and businesses

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Innovation Beyond Borders

Digitization allows physical objects or characteristics to be visualized and controlled through data, blurring ownership lines. Data owners now have increasing control over object owners. This new information power balance goes beyond digital and physical realms, changing the social framework.

Changes Caused by Digitization

Digital disruption is transforming traditional business models and the fabric of society. Prime examples of this shift are Uber and Airbnb, which have significantly changed the transportation and lodging industries.

Behind the rise of digital innovation are technological advances allowing the capture of objects as data, which subsequently make it easier to control things and solve problems. For example, the low-cost launching of compact satellites by reusable vehicles are about to become a reality. This in turn will allow the collection of more data, improving the accuracy of weather forecasting and the prediction of natural disasters such as typhoons and hurricanes. Advances in digitization may also make possible the use of human voice and facial expressions to understand emotions, and/or brain-wave data to learn an individual's thoughts and desires at a deep psychological level. Our society and businesses are now in the midst of revolutionary changes, tearing down traditional business frameworks and creating a new balance of power.

Data Ownership Resulting in Redesign of Industries

One of the impacts that the digital revolution is having on society is a power shift in who controls data. Technological advancements in tools for visualizing information, previously accessible only by a select group of industry experts, now are available to everyone. This shift makes it easier for new players to enter the marketplace and democratizes data ownership across a variety of fields. It is transforming the fabric and structure of industry today.

In the healthcare industry the power to control medical information is transitioning from the hospital to the individual. For instance, patient laboratory information has traditionally been managed by hospitals, with patients paying fees and spending time and effort to obtain copies. Now systems are becoming widely available that consolidate patient health records, making them available on smart devices. As a result, patients are able to manage their own health information. The system even allows patients to disclose medical information to other, trusted physicians and hospitals to receive medical advice. This access stems from the emergence of a new technology that protects medical information while enabling its distribution. Both a global IT company and healthcare companies are providing such services that have applications in many industries.

Another example of a transferal of information control is taking place in car manufacturing. One company is focused on becoming a platform for mobility services by consolidating data around the automobile, transforming the concept into a "mobility space" as a retail platform for shopping, movie theaters and restaurants. Expanding the idea of the automobile from simple transportation into a platform for services will benefit multiple sectors. However, such a transformation has the potential to exclude the services associated with the car manufacture itself, enabling new global leaders to emerge.

Merging of the Digital and Physical Worlds

Merging of the digital and physical worlds has allowed a change in the power to control physical spaces. With the help of XR[1] space, humans can now act and communicate beyond physical boundaries, working alongside and connecting with people in remote locations regardless of time and geography. This space also permits us to virtually recreate scenes and experiences that are difficult to replicate in the physical world.

A variety of industries are adopting the head-mounted, holographic display needed to enter an XR space. For example, people in the construction industry can use a 3D hologram during the design phase of a building to view it from all angles in its completed state and to actually walk inside the building. In addition, architects and builders will soon be able to remotely join the construction site as avatars in order to share real-time information with others. Similarly in the manufacturing industry, XR allows remote employees who work at production sites that may be inaccessible due to harsh conditions to share personalized knowledge and skills. Digitization has the power to provide greater access to many things, allowing individuals to transcend the physical limitations of being human.

A Shift in the Balance of Power

Paradigm-changing, digital-driven innovations are transforming traditional business models and interactions with customers. For instance, Mobility as a Service (MaaS)[2] has the potential to transform the way we experience travel itself. The current goal is to create a one-stop reservation system for public transportation and air travel, eventually linking this service to a self-driving car that can be dispatched when passengers are one mile from a given destination. Connecting this to a sharing service will also enable customers to incorporate preferred services into travels and tours, thereby building a customized experience. In the near future, it may become commonplace to seamlessly travel within cities and regions across entire countries and the globe.

Platformers and startup companies not bound by conventional values are becoming leading competitors in this business transformation. Along with these new players, well-established organizations and local governments that are responsible for infrastructure will leverage digital technology to become a driving force for social change.

Borderless Innovation

In a digitally advanced society, physical and spatial constraints will disappear, enabling borderless innovation across countries and corporations. Furthermore, the advancement of this trend removes the boundaries between existing industrial structures, further driving transformation and creating new business and social systems.

1 A collective term for technologies such as Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR).

2 Mobility as a Service (MaaS) is a movement to combine self-driving cars, AI, open data and other technologies, and integrate the conventional transport and travel means with sharing services to create next-generation transportation.

IST 02

Power of the Individual

The growing influence of the individual is changing social systems and business. Once harnessed, information possessed by an individual becomes the basis for creating new value, which in turn forms the foundation for the continuous growth and progression of companies and society in the future.

The Expansion of Individual Power

Technology has shifted power to the hands of individuals. This is partially due to the proliferation of mobile devices and high-speed internet, which has enabled people to send personal messages through social networking services and access endless streams of information. Using low-cost digital services to engage others, individuals now possess the power to change the fabric of society itself. For example, a US high school student developed a communication tool for patients who had lost all voluntary movement except for eye movement. Using eye tracking and a brain-computer interface to find the best-suited emoticons, emoji and characters, she was able to convert results into a text message that could be transmitted to the patient's attendant. Armed with technology and her own experiences as a youth volunteer, a single individual solved a problem driving societal change.

The Shift to an Experience-Driven Business Model

Companies are transforming their business models to deliver targeted, individualized experiences to consumers to harness the power of the individual. For example, an online streaming services company provides attractive, personalized recommendations for new items by analyzing a user's history and presenting images that the user finds attractive. Another example is a service that uses a simple device to collect data and aggregate daily-life logs, which presents health-related recommendations to a user. Lastly, a new food planning application delivers customized meals to fit specific dietary and physical needs. The program may even use 3D printing in the future to showcase the requested meal.

Organizations are also using the power of the individual to target marketing efforts to desired demographics. For instance, luxury brands are turning overwhelmingly to online influencers with numerous followers as a cornerstone of marketing strategies. This approach reinforces brand value and creates awareness especially with virtual influencers who in turn reduce the costs and risks associated with human influencers. New business models capitalize on the power of the individual to make tailored appeals based on specific preferences and behaviors derived from smart devices, which have become indispensable as an interface between the individual and society.

The Value of Personal Information

The megatrend of personal information clearly demonstrates its great value. In fact, the very words, thoughts and behaviors of individuals have become the primary source for generating future value. As individual preferences and choices increase in value and influence, one question is becoming predominant. To what extent should individuals share information with others?

We enjoy personalized services and networks by providing personal information. In addition, platformers that monopolize huge amounts of data on which we are reliant are becoming colossal forces in society. This trend may continue in the future. However, some efforts are underway to control and regulate personal data.[1] One solution growing in popularity is information banks. These banks store the personal data of users based on a predetermined agreement and provide this data to third parties. The approach aims to safely manage personal data and extract its maximum value, while preventing an excessive degree of monopoly. This framework also shifts the balance of power and control of personal data back to the individual.

The Race to Attract High-Skilled Human Capital

In a society where individual abilities and intentions generate value, companies can no longer survive by recruiting people simply as a 9-to-5 workforce. Creation of businesses focusing deeply on each and every individual requires the acquisition of human capital to leverage ideas and technologies to solve major social and corporate issues. As a result, the trend to respect and harness employees' personalities and differences is going mainstream among companies.

One example of this is taking place in the sporting goods sector. In light of the diversification of buyers of sporting goods to include fashion-conscious women, health-oriented senior citizens and physically-disabled athletes, a sporting goods manufacturer is now recruiting a more diverse workforce to create competitive products. To accomplish this, the company established a family-friendly environment and promoted respect for individuality as a core company value.

Such changes in the acquisition of human resources are spreading beyond national borders. A 2018 report issued by a U.S. consulting firm[2] stated that there will be a global shortage of more than 85 million high-skilled workers by 2030, resulting in a loss of as much as $8.5 trillion. Given these circumstances, Canada and China are preferentially accepting immigrants with specific expertise, giving them favored treatment such as subsidized living expenses. Since approximately the year 2000, the type of immigrants who move from emerging countries to developed countries such as Europe and the United States has been shifting from unskilled laborers to skilled workers. Now that trend is about to reach Asia.

Businesses focusing deeply on the individual will gain a competitive edge by hiring skilled employees. Changes in recruitment and retention practices by companies and governments are critical for continued success and prosperity.

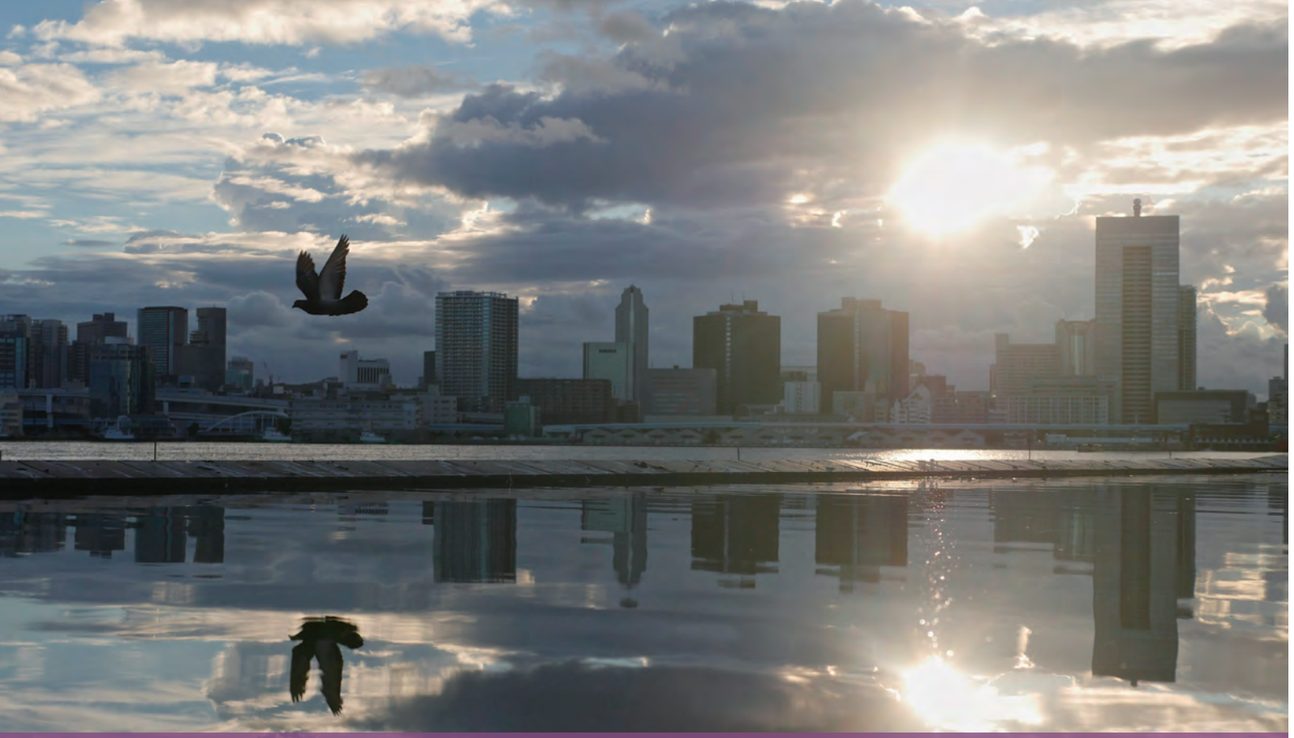
The Individual as a Core Building Block

With the era of mass production and consumption behind us, companies must provide personalized products and services to remain competitive. The success of this depends not only on the products and services themselves, but also on the value of the information provided by the individual consumer.

The starting point for a business focusing deeply on each individual is acquiring the information that the consumer possesses. In fact, the data or information that an individual has is of such great value that it is now sometimes referred to as the "new petroleum." Accordingly, leaks and inappropriate treatment of personal and other data poses a material risk for both the individual and the company. With control over personal data in the hands of the individual user, future companies and society as a whole must design products and services that leverage the power and information provided by individual consumers. In short, the ideas and information that the individual holds has become the key source of innovation and sustainable development.

1 References to personal data includes data as defined in the General Data Protection Regulation (GDPR) as well as information related personal attributes, travel/activity/purchase histories and information collected by wearable devices.

2 The $8.5 Trillion Talent Shortage, May, 2018, Korn Ferry Institute.



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Social Impact of Technology

Technologies bring benefits while concurrently polarizing society into two groups: those who leverage technology and those who do not. To prevent growing social imbalance, people must change behavior to coexist with technologies while adapting culture and regulations.

A Technological Social Divide

Although technology improves lives, it can also create a digital divide[1]. Technological advances have afforded humans a variety of benefits, including instant, global communications, lower costs for generating innovation and the means to convert ideas into tangible form. In fact, technology itself helps to generate new services and innovations, which in turn creates other technologies in a virtuous cycle. It may, however, produce unforeseen, new social barriers.

The worst scenario is that people will become divided into technological haves and have-nots. While a community may enjoy significant benefits from technologies as a whole, the cost for leveraging technology increases over time, potentially making homogenous members unite with one another. For instance, using technology to eliminate geographical and temporal limitations, it is simple for technology-savvy individuals to move to preferred locations to improve lifestyles, maximize profitability and protect intellectual property. As a result, innovators typically gather in more loosely regulated countries and regions, making them centers of global innovation.

There is also a possibility that the technological gap between the haves and have-nots or the supporters and opponents of innovation, will deepen. One example of this is the advanced medical care enabled for some by HealthTech,[2] while other less wealthy individuals may not be able to obtain even basic medical care. If social benefits require both knowledge of technology and wealth, vulnerable members of society may be left behind.

A Warning About the Digital Divide

Geographic location and demographics contribute to widening the digital divide. This socioeconomic divide precludes those in rural areas or lower social classes from benefits only afforded to those with access to technology. In addition, senior citizens less familiar with digital technology may oppose its adoption. As technology becomes commonplace, digital illiteracy becomes directly linked to social disadvantages and risks.

The impact of a digital divide is evident in Sweden, a country that has a cash circulation rate of approximately 1.4%, less than its Gross Domestic Product (GDP)[3] and prompting its reputation as a near cashless society. A group of older citizens less familiar with digital devices, together with those who fear the risk of cyberattacks, have launched an opposition organization called Kontantupproret (Cash Rebellion), appealing for the continuation and use of cash.

Emerging Issues

In an era where the internet of things (IoT) connects all including people and money, sensors track the thoughts and actions of individuals and companies and spread that information worldwide through online networks. While this phenomenon may improve convenience and service quality, it also creates an environment vulnerable to cyberattacks. To counter this security threat, society must mobilize the knowledge and power of a variety of stakeholders ranging from individuals to companies and national governments.

While the advancement of AI has enabled the automatic development of diverse content, it has also resulted in the generation and dissemination of false information. This is now an extremely serious issue. Anyone with a basic amount of technical knowledge and skill can create believable, fake data. For example, an AI-generated bogus video portraying an electoral candidate insulting an opponent can look perfectly natural to viewers. The use of such sophisticated fake data can further deepen individual or methodological biases. To counteract this societal threat, AI must once again be employed in order to detect and counteract false information.

The Need for Ethics

Synthetic biology, which modifies genomes to synthesize new cells and organisms, and genetic editing technology that operate on genes that cause disease, will likely help find cures for intractable diseases and produce crops that can survive environmental changes. Conversely, these same technologies trigger major ethical questions and may create unforeseen threats. For instance, in China a doctor claimed he edited the genes of twin babies. This news garnered global attention and created a significant ethical and regulatory debate. How should we address the ethical issues and implications arising from emerging technologies? The answer to this question will be of the utmost importance in the future.

Choices That Confront Us

A digitally, advanced society will likely provide unprecedented advantages. However, the slightest misstep in technical and biological innovations may result in substantial moral and ethical problems. To mitigate this, efforts are underway in the U.S. to create a guidebook on the ethical impact of technology. In addition, the European Union (EU) has defined its policy to protect individuals affected by innovations. These guidelines for AI ethics include requirements for developing an AI system to eliminate discrimination and provide human oversight to track and intervene, if necessary, AI decisions. Also, the EU implemented its General Data Protection Regulation (GDPR), a policy to protect the personal data and privacy of its citizens.

To coexist with changing technology, society can foster ethical standards, institute societal rules and regulations, or combine both approaches. The appropriate equilibrium point of ethics versus regulations is yet to be determined. Nonetheless, while the existence of rules will encourage emerging innovations consistent with them, a trial-and-error search for this balance will likely continue to be a major social issue.

1 An issue that produces an informational gap between people who have the ability to use and opportunities to access information technology such as personal computers and the internet, and those who do not.

2 Coined from “health” and “technology,” this term refers to an emerging medical service or innovation that utilizes state-of-the-art digital technology.

3 The Current State of Cashless Payments, by the Payment and Settlement Systems Department, the Bank of Japan, September 2018.

IST 04

Sustainable Society

Resolving global issues fosters open collaboration within society. Collective business strategies together with this transformation will encourage the expansion of global opportunities and resolve uneven resource allocations. A more sustainable society and business environment will be created.

Recognition of Sustainable Growth Concerns

Technology has provided countless advantages to people and enterprises, but also it has raised ethical issues and created a burden on the global environment. Seeking only an affluent life and convenient services may lead to the imposition of disadvantages on some communities and increase environmental pollution. People and companies are now recognizing these environmental concerns, and are incorporating these limitations within their activities and plans.

Solving Global Issues

Issues ranging from population movement, to climate change, food crisis, differences in values, diffusion of authority and internet governance are challenging society. Against this global backdrop, the United Nations established the Sustainable Development Goals (SDGs[1]) in 2015. These goals include the securement of a healthy and safe life and environment, the elimination of social disadvantages and the improvement of quality of life for individuals. The SDGs created a major trend where nations, regions, companies and even individuals cooperate. Management based on environmental, social and governance (ESG[2]) factors is also impacting corporate strategy. The rationale for ESG is to bring corporate activity in line with global social and environmental issues, leading to increased organizational flexibility and sustainable growth. The ability to foresee and collaborate on such global issues will be the source of future corporate value.

Rebuilding Strategy from a Circular Point of View

How should organizations respond to the SDGs and ESG? The answer is simple. Reevaluate the essence of a company from a sustainability-based, circular viewpoint. The Circular Economy Package[3] announced by the EU in 2015 and implemented in 2018, aims to protect businesses from the depletion of resources and price fluctuations, enhance corporate ability for international competition and produce sustainable development and job growth.

Efforts are underway to incorporate this circular business model into corporate strategy to promote responsible and sustainable business growth. For example, a Danish electric power company incrementally abolished its fossil fuel thermal power generation, converting it to offshore wind and biomass. This effort restructured a declining business while contributing to the environment. Another instance of such efforts is a food manufacturing company that invested in technological developments in satellite sensing to monitor and reduce its own marine plastic pollution. Sustainability marine resources, which constituted the core business activity of the organization, improved the company's own sustainability.

Reevaluating corporate activity from the circular economy perspective may not be sufficient to solve all of issues that exist in a business' value chain. What is required is open collaboration between competitors, industries, venture companies, governments and even individuals.

The Role of Technology

From the circular economy perspective, usable resources, energy sources, aging infrastructures and excess urban functions still exist. However, by using technology to identify, share and utilize resources in new ways, the sharing economy can be considered a circular platform. Examples of this approach include a startup company in Australia that uses block chain technology to let individuals freely buy and sell electric power generated from solar panels. This creates economic and environmental advantages for both the sellers and buyers of electric power. In addition, a British university is developing a system that stores energy in a liquified form. Implementation of this technology may enable the charging of electric cars in the same way gasoline is used in conventional cars, possibly repurposing the existing infrastructure of gasoline stations.

The Realization of a Sustainable Society

A technology-based information society has the potential to overcome challenges. To accomplish this, the world must reexamine the social, business and living environments under which we are placed from a circular economy perspective. If individuals and businesses use technology to connect resources, the environment and social systems, and coordinate partnerships in a circular way, a sustainable society may yet be achieved.

1 Adopted by world leaders at the United Nations Summit in September 2015, these 17 international goals are aimed at building an inclusive society by 2030.

2 The United Nation's April, 2006 announcement of the Principles for Responsible Investment suggested that companies incorporate environmental, social and governance factors into business investment strategies.

3 Adopted by the European Commission in December 2015, this is an action plan to convert Europe into a circular economy to increase international competitiveness, enhance sustainable economic growth and create jobs. Implemented in 2018 as one of its specific strategies, the European strategy for plastics also garnered worldwide attention.

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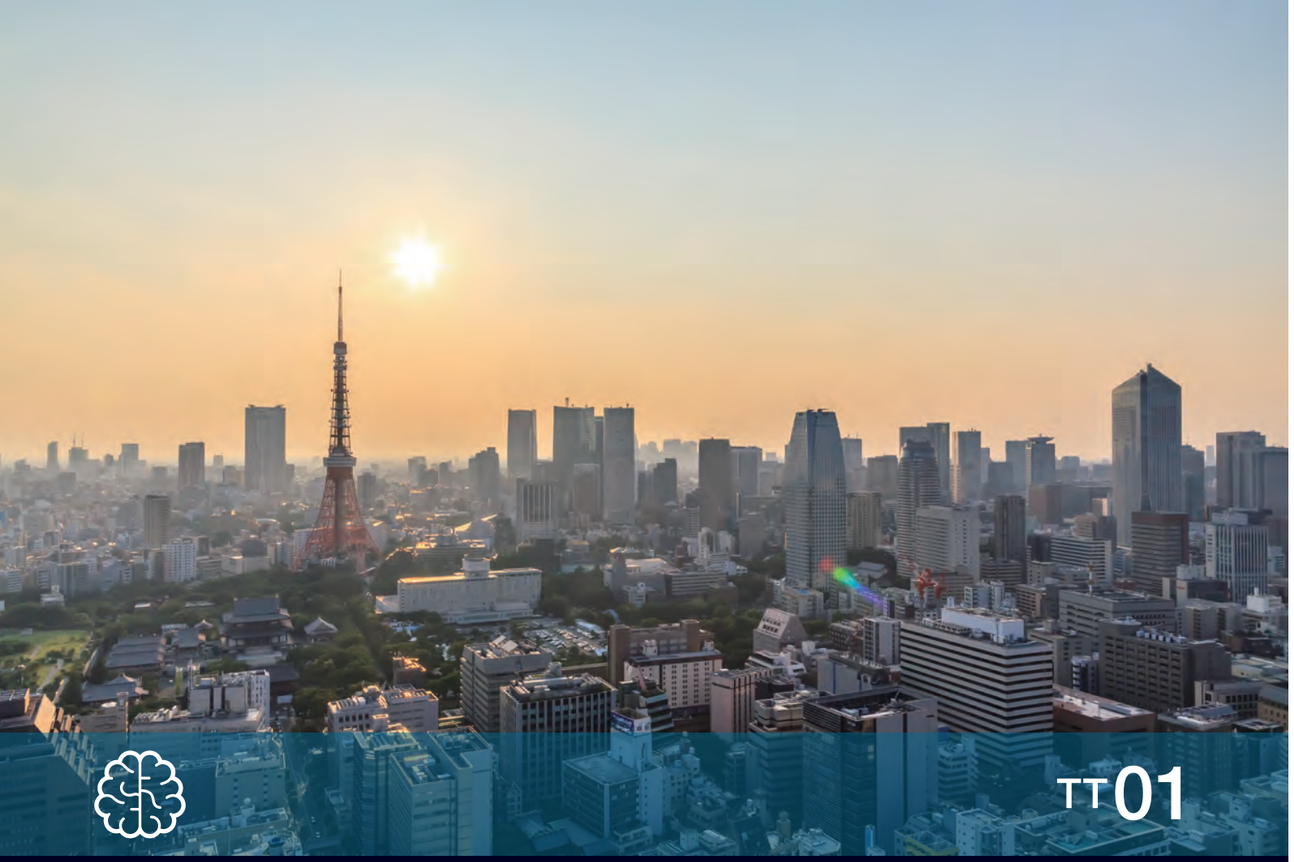
Technology Trends

Technology trends spearheading development of an information society



TT01

Socially Accepted AI

As AI continues to permeate society, practical issues are emerging. Technology advancements that improve both the accuracy and ease of building AI will further expand its application. Additionally, ensuring transparency will create more socially accepted AI, accelerating its integration into society.

Improving AI Development and Maintenance

As AI becomes commonplace and the myth of an omnipotent AI dispelled, users are focusing on its practical applications. One factor that has popularized AI is technology that makes it easier to develop. Deep learning acted as a catalyst for today's AI boom by achieving an overwhelming degree of accuracy over traditional methods at an image recognition contest in 2012. This initiated a significant boost in AI-related research and the building of development frameworks. Consequently, advanced deep-learning-based services are now considerably easier to develop. However, expertise in neural network structures and parameter tuning is needed to further improve accuracy.

In 2018, Google launched a service called Cloud AutoML, which automatically generates high-quality, machine learning models. With use of this service, the learning data itself is all that is required to build an accurate AI system. As a result, AI will likely begin to permeate fields where its application has been slow due to lack of expertise.

To sustain performance, AI requires maintenance, including adaptation to environmental changes and resolution of issues identified after implementation. As AI pervades society and business, maintenance costs and upgrades will become increasingly important. One solution to this issue is a technology called active learning, in which AI automatically identifies and learns from cases where it has low confidence in its understanding, efficiently improving its accuracy. Use of active learning not only generates judgement improvements, but enables a proactive division of labor between humans and AI. Moreover, these technological advancements streamline the task of AI experts, easing the global AI labor shortage.

Efforts to Better Learn and Adapt

While AI has outperformed humans in the accuracy of image and voice recognition within a controlled, research environment, it is important to remember that AI and humans recognize things differently in the real world. For example, a person can easily recognize the attributes of a can of beer – the brand, that it's an alcoholic beverage for consumption by adults, if it is full or empty, and if it is cold or warm. AI, on the other hand, lacks this cognitive capacity and it is impractical to provide AI with all real-world knowledge in its entirety.

One approach to resolve this difference is called embodied AI. Humans acquire knowledge through interactions with society and by using the five senses. Assuming both a physical body and intelligence are necessary to acquire certain knowledge, this method uses an AI robot with sensors to move around the environment and look at, listen to and touch objects. If this approach proves successful, AI will likely be able to make physical connections to objects and adapt to individual situations in a more flexible way.

There is also a significant deviation in the amount of data and time humans and AI require to learn a task. AI must learn any new undertaking from scratch using huge amounts of data, while humans can learn incrementally with minimal input. This is because humans have accrued a basis for learning. One means for AI to develop this human capacity is called meta learning. Using meta learning a robot can replicate a simple task, like placing an object in one of multiple containers that are set in different positions, after viewing a video that shows the relevant movements. Further advancement of this technology will likely widen the range of AI applications for manufacturing and home robots.

The Transparency Requirement

While AI has already been implemented in loan screening, adoption of recruitment criteria and prediction of repeat criminal offenses, it sometimes causes problems because its logic is not transparent. For instance, one case found that the AI was using a logic that gave priority to men over women in a recruitment process. To use AI in fields that deal with lives, including self-driving cars and medical diagnoses, accountability is required to prevent such potential problems.

Against this background, development of technologies to enable AI to explain the basis for its judgment are gaining momentum. One of these projects is called visual question answering that allows AI to answer relevant questions about a given image. For instance, to answer a question about what kind of sport children are playing, AI must distinguish objects in the image such as children as well as the type of ball. To date, AI has been able to visualize the basis for its judgment and verbalize an explanation with such an image.

In healthcare, researchers are experimenting with ways to present patient data and physicians' diagnostic notes that corroborate AI prediction of death risks of inpatients and duration of hospitalization. Due to the complex and entangled factors involved in such decision-making, it is crucial to present an objective basis to physicians for judgment. Elucidating the basis for judgment will likely empower people to make faster decisions with confidence based on AI predicted results.

Progress toward Socially Accepted AI

While the rapid advancement of AI technologies has resulted in convenience and efficiency, ethical issues have emerged including privacy concerns, discrimination and apprehension over AI-based weapons. In fact, the utilization of AI in various fields has led to an increased need to address AI-related ethics. In the future, companies will be required to assume social responsibility while creating innovations and new services using AI.

A world where humans and AI coexist will necessitate an ethical methodology for solving these types of issues. To undertake this, a project called the Moral Machine collects and visualizes opinions about the moral basis of AI decisions as it relates to self-driving cars. In making such judgements, different nations and cultures may have disparate ideas about the priority of decision criteria in case of an accident, i.e., pedestrians, passengers, the number of people saved or a person's age. Self-driving cars may even have to be equipped with variable decision priorities depending on the country. The establishment of a social environment and principles by which governments, corporations and users can cooperate to make AI accepted will lead to a society where the advantages of AI can be experienced by all.

Usable Augmented Data

In an era where data quality dictates business success, more usable and complete data by augmentation will be critical as mixing good with bad data continues. The development of technologies that generate and refine data will expand the possibilities of data usage.

The Increasing Value of Data

Within our society, several enormous digital platformers market innovative technologies and services in rapid succession to sustain rapid growth. This is creating a virtual monopoly of data and nations and other corporations are waging data battles by, for example, restricting data export beyond national borders. These fights stem from the fact that data has become an indispensable business driver and a primary source for national and corporate economic growth. This is indicated by the fact that data is sometimes referred to as the new oil. Emails, social networking services, voice assistants, electronic commerce websites and conveniences that we take for granted are continuously generating new data used to analyze consumer preferences and improve AI performance. In addition, once data creates a new service, yet another new service is produced using information from the first service, thereby creating a virtuous cycle.

Even after huge amounts of data are secured no new value can be created without the technologies and ideas that utilize the data. Recent advancements in AI technology are propelling data utilization to a new level. However, in addition to its potential benefit, this progress also presents new challenges.

The Data Bias Challenge

Data bias is causing societal problems and concerns with both data analysis and AI learning. For example, some AI-based face recognition programs have significant variances in accuracy depending upon gender and race. Because of this, the use of these AI programs for security purposes often results in unjust differentiation, whereby a specified group is asked to go through additional security checks. Although added learning data enables AI to perform more accurately, it may also be necessary to uniformly organize learning data to control for object-dependent variations, even if it results in less overall accuracy.

Numerous other issues are resulting from data-based bias. For example, AI that predicts recidivism is controversial because it produces biased predictions based on race. This situation arises not from bias within the learning data, but from absorbing historical data and applying it, without question, to predict the future. AI makes decisions based on the data it has learned assuming a causal relationship, even though only a correlation actually exists. For instance, because the possibility of repeat offenses tends to be higher in the past for a certain race does not mean that particular race is the cause of repeat offenses.

What is required is fair and secure AI that individuals and society can use. To attain this, organizations must verify bias in learning data and processing logic. In 2018, multiple companies announced tools to detect AI bias. In the future, companies must resolve any problematic bias in order to gain social trust and sustainable growth.

Verification of Authenticity

With the launch of software using deepfake, a synthesis technology that can replace one human face in a video with another, it has become relatively easy for anyone to create fraudulent videos. Consequently, fake videos with inserted faces of celebrities and election candidates are now in global circulation, causing social issues such as the infringement of image and human rights and the manipulation of public opinion. Furthermore, voice synthesis technology has also evolved. In fact, only one minute of voice data is now sufficient to create any length of virtual speech. Combining fake video with voice capability will make the differentiation of what is authentic more difficult. Adding to the confusion and potential fraud, AI can also create verisimilar text. Once a person writes an initial sentence, AI can produce subsequent sentences in a similar style on any topic.

To address these and other problems, the development of technologies to detect fraudulent content has become vital. For example, a service that detects synthesized images and videos posted on social networks in real time has been launched. In addition, the U.S. Defense Advanced Research Projects Agency (DARPA) has established a media forensics program to develop sophisticated tools to detect fake videos, images and voice. This detection program focuses on physiological characteristics of humans that AI cannot replicate, such as unnatural eye and head movements. However, the elucidation of a fault in fake data will likely motivate the development of yet another technology to counteract it. In fact, technology has emerged already that elaborately imitates the motion of blinking eyes and head movements after a face is replaced within an image.

The battle between the synthesis technologies that further improve realness and those that detect fakery is expected to continue into the foreseeable future. To make matters more confusing, about 60% of articles on a social networking service are shared without actually opening the article itself[1], spreading information due to its attention-grabbing title. As a result, advancement of technology to eliminate fake data while refining real data, and the improvement of user literacy are critical.

A New Potential for Synthetic Data

While AI-based data generation technology increases fake content, it also creates the potential for enhanced data utilization. One such advancement is a technology called Generative Adversarial Networks (GANs), which generates synthetic images and videos indistinguishable from the real thing. Technology has also emerged to recreate specific characteristics and styles of such generated objects. For example, the technology can specify during the generation of a human face the angle of the face, hair style, eye and nose characteristics and skin color. Improvement in AI's accuracy and minimization of bias can be expected through the use of such learning data.

Another factor encouraging the use of synthetic data is the advancement of a technology called domain adaptation. This method applies knowledge acquired through the learning data of one domain to another domain. Based on knowledge acquired via a virtual CG space, this technology has the hidden potential to solve real-world problems for which sufficient learning data is unavailable. For instance, robot arms and self-driving cars can already be partially controlled through simulation-based learning in a virtual CG space. Thus the advancement of technology to synthesize realistic data combined with learning methods adaptable to the real world, will expand its applicability in the years ahead.

Simulation learning allows AI to acquire knowledge in a short time through high-speed and parallel processing, and prepares AI to adapt to extraordinary situations. For instance, simulation learning for self-driving cars permits AI to prepare for blizzards, dense fog and other natural phenomena, as well as situations too risky to replicate, e.g., a pedestrian or motorcycle suddenly appearing in the road. In the future, how to process and generate data that improves AI accuracy will likely become a key source of competitive advantage. Today, as it becomes difficult to differentiate between real and fake data, society requires a means to eliminate counterfeit content while still benefitting from valuable, synthetic data.

1 Social Clicks: What and Who Gets Read on Twitter?

TT03

Digital Life Science

IT has progressed beyond promoting healthier behaviors and supporting medicine. Monitoring devices enable at-will diagnosis and change the way people access medical care. IT involvement in genetic and cerebral disorders have also initiated research in incurable diseases and life extension.

Growing Role of IT in Healthcare

In September 2018, the Apple Watch Series 4 was released. This update increased the watch's significance not only with performance improvement, but also in the field of healthcare. The reason is that advancement in heart rate sensors led to the U.S. Food and Drug Administration (FDA) approval of the watch's sensors for electrocardiograms and detection of irregular heart rhythms, enabling users to monitor their own conditions. Traditionally, electrocardiograms were taken when patients noticed a change in heart rhythm and went to the hospital for observation. Other patients would be given a Holter monitor to wear to measure their activity, during which the symptom might not recur. Now patients can take their own electrocardiograms. A similar device that received FDA approval is a smartwatch that senses movement and electrical fluctuations in the skin to detect an epileptic seizure.

It is now becoming a reality for individually owned devices to detect certain physical conditions through regular monitoring. Moreover, an increase in the use of these devices will allow the continuous collection of physical activity logs and biological information, which in turn will enable the understanding of idiosyncratic, abnormal conditions increasing detection accuracy. In the near future, it will likely be possible to identify the factors that cause abnormalities and to use devices to detect pathological signs.

Next Generation Healthcare

Another significant change is occurring to the diagnostic equipment used in hospitals. While AI was used previously to assist physicians with diagnoses, in April 2018, the FDA approved the sale of equipment that uses AI for diagnosis without a physician. This particular AI diagnoses diabetic retinopathy. If it determines that retinopathy is present, it recommends a visit to an expert. If the AI finds that retinopathy is not present, it advises the patient to take another test within a year. Despite the need for a physician to provide final diagnostic verification, this approval by the FDA is expected to significantly change the role of AI in healthcare. More devices that enable diagnosis by AI only will become available in the future, transforming the physician's role and potentially the structure of the healthcare industry.

Due to the increasing number of medical software programs, it is now inefficient to inspect the software every time it updates functions. As a result, in 2017, the FDA launched a pilot program called Digital Health Software Precertification. This pilot was launched to establish a system to streamline the inspection of medical software by precertifying companies that develop such software and simplifying the information submitted to the FDA. It is anticipated that this trend will further expand the participation of IT companies in the clinical realm.

Growing Hopes for Digital Medicine

The world's dementia patient population is estimated to be 50 million in 2018 and predicted to reach 152 million by 2050[1]. In 2018, however, a series of major pharmaceutical companies announced the discontinuation of dementia drug development. One factor influencing this decision is the long progression time of dementia, which necessitates study periods lasting several decades. Another factor is the lack of objective, quantitative indices for the assessment of drug efficacy as well as the need for costly, physician interviews to assess patients.

Given this situation, a new approach garnering attention is digital therapeutics, which is a non-drug treatment that works by combining software and devices. While there are no radical therapies established for dementia, there are symptomatic therapies that slow its progression by recalling past experiences and memories. One hypothesis is that the memory itself is not lost, but that access to the memory is disabled for patients with Alzheimer's disease, which accounts for about 60% of the dementia population. If this hypothesis is correct, it might be possible to recover the access by repeatedly looking at past memories to help retrain the brain. To assist with this, a system is being developed that stores digital data about people, places, things and daily routines. This system would enable the automatic monitoring and evaluation of a patient's condition using questions and games about past memories.

Digital therapeutics using video games is also under development to treat Attention-Deficit Hyperactivity Disorder (ADHD). This video game treatment is based on cognitive science that uses games to provide sensory and locomotor stimulation, thereby improving perceptual, visual and simultaneous execution. An experiment on more than 300 children reported that their attention ability improved using this therapy. Approval by the FDA would enable these treatments to be prescribed just like conventional drugs to patients.

By using technologies readily available in everyday life, digital therapeutics allow intervention not only in the ailments of patients, but also in their lifestyle habits and consciousness regardless of place and time. This means that patient adherence can be expected to improve as individuals become willing to actively and continuously receive therapies. Digital therapeutics and digital medicines also enable patients to share data with their physicians via digital devices. Accumulation of more data can lead to more effective therapeutic drugs, and the use of wearable devices will enable analysis that incorporates biological information. These possibilities will likely create the kind of healthcare that unifies prevention, diagnosis and therapy, while contributing to the control of social and monetary expenses.

Digital Intervention in Gene and Brain Sciences

The power of digital technology is being extensively used in sciences related to the brain and genes. One of these technologies is a therapy that uses brain information in the form of neurofeedback. In the past, neurofeedback, which monitors the status of brain waves to train the brain, was used to treat ADHD and depression. In recent years, the emergence of low-cost headsets that measure brain waves and the permeation of smartphones have facilitated neurofeedback therapy using a mobile application, regardless of location.

Gene editing technology is also raising hopes in the treatment of intractable diseases. Such technology may assist in the diagnosis of diseases using blood, saliva and urine, and it has already been successful in detecting Zika and Dengue fever and other diseases. Requiring only a disposable test strip, gene editing technology can quickly diagnose a variety of diseases at low cost.

Biotechnology and digital technology is also being used to produce body parts. This method creates living tissues and organs by means of bio-inks, which are biomaterials that make up living cells and used by a 3D printer. For example, a portable 3D printer is being developed to build skin tissue layers to cover a wound. In addition, a study successfully produced a 3D-printed cornea and some companies are working on producing 3D-printed lungs. As a result of these advancements a day may come when all organs can be artificially created, overcoming the severe shortage of donors.

On the other hand, the birth of gene-edited babies is generating significant ethical and safety controversies. Any attempts to produce intellectually and/or physically enhanced children may result in widespread eugenics. Modification of bacteria and viruses could also be utilized to create new bioweapons. The ways in which society addresses such challenges, including the establishment of ethical guidelines and principles as well as countermeasures for threats, may hold the key to the resolution of life-related issues for humans.

1 Alzheimer's Disease International, London, World Alzheimer Report 2018

TT04

Natural Interaction

Conversation between humans and machines is becoming a normal part of life. Machines respond to user instructions, emotions and the context of communication. As machines communicate more naturally, they will provide people with new insights and assist human thinking.

Conversations With Machines

Humans are increasingly talking with computers. Upwards of 100 million smartphones are currently equipped with a voice assistant and the sales of smart speakers are rapidly increasing. Microwave ovens, refrigerators, toilets and even electronic pianos are being equipped with voice interfaces. In addition, a chaotic array of services exists for text-based chatbots, which are being adopted by many companies.

These products offer a broad range of functions including information search, device operation and product ordering, although only a limited number of these capabilities are being used on a regular basis. A 2018 study[1] reported that approximately 60% of smart speakers were used primarily for playing music, with other capabilities such as the operation of home electronics far less popular. For such interfaces with machines to become more useful, machines must be able to converse with people in a more natural way.

Improving Conversational Ability With Memory

Efforts toward making conversations with machines more natural are progressing, with one effort focusing on conversation continuity. A conversation never ends with just one exchange of sentences. It continues in a sequence, during which the subject and object of a sentence are frequently omitted. While humans can infer this omitted information, it is difficult for machines to do so. Furthermore, machines presently require a wakeup command to start themselves. Some voice assistants have overcome this problem except for the first time you speak to them. Machines can also memorize the content of previous conversations, helping to determine omitted subjects and objects in a sentence.

The best current example of technology that uses this type of continuity and conversational memory is called Duplex, an AI technology recently released by Google. It enables AI to have exchanges similar to human phone conversations. Other initiatives underway are focusing on the use of longer-term memory. Such machines can recall content after being instructed by a human partner and provide data like the weather without added directives. The ability to carry on a conversation while searching memory will make human-machine communication more natural, eliminating the need to ask the same questions again and again.

The Need for Understanding Context

Research is underway on AI-based natural language processing, although progress has been slow when compared to other AI-related capabilities such as image recognition. This is due to a variety of problems including the presence of words with multiple meanings and the lack of learning data. However, new technology has emerged to help resolve these problems, which considers context to correctly determine the meaning of words. Using this technology, a model containing pre-learned data has been introduced. As a result, the machine only needs small amounts of data to learn various tasks including the extraction of location, people and other named entities and to appropriately answer questions. In fact, the use of this technology and model received high scores in eleven tests that are used to measure the accuracy of natural language processing, such as the Stanford Question Answering Dataset (SQuAD.) The advancement of AI is expected to provide a key to the ability of machines to accurately and flexibly respond to spontaneous conversations with humans.

Using Nonverbal Information

Approximately 35% of conversational messages are communicated verbally, with the remaining 65% deduced from nonverbal gestures, facial expression and so on[2]. Mastery of nonverbal information will enhance the ability of machine-to-human communications to more closely replicate human-to-human conversations.

To capture nonverbal information, researchers are actively working on the sensing of human expressions used in conversation. For example, recent research has developed a chatbot that infers its partner's mood based on facial expressions. This chatbot can also display an expression that matches its human partner. For instance, the chatbot speaks with a smile to a happy partner and a worried look to an unhappy partner. A machines'ability to recognize and react to a partner's expression will likely improve machine conversations with people.

The use of nonverbal information is also evolving in many other fields, such as inferring emotion based on tone of voice and generating an emotive comment like "Cute!" based on an image. A machine's ability to capture emotions and to understand surroundings, as well as a partner's situation, will enable it to detect subtle emotional changes in a person and adapt appropriately in real time. Two illustrations of this trend are a robot assistant that suggests taking cold medicine when its partner sneezes, and a chatbot that infers the possibility of depression based on a conversation.

The Benefits of Conversing With Machines

Humans initiate conversations as a consequence of a diverse array of motives including questions, instructions, empathy and stress alleviation as well as a means of persuasion. After acquiring the ability to converse naturally at a human level and understand situations and emotions, machines will likely be prevalent in many situations where humans engage in conversations. For example, a system that listens to a human-to-human conversation to display in real time the information relevant to the conversation has enormous potential to assist in enhancing understanding between speakers of different nationalities and generations.

Debate showdowns between humans and machines served as one of the catalysts to realize machines' future interactive capabilities. Machines have made significant progress when competing against human debate champions. Machines now use the enormous amount of knowledge stored to unpack a given first-time topic and to construct a thesis to advocate, while connecting arguments to facilitate human understanding. As a result, the day may come when humans engage in a series of discussions with machines to inspire new ideas and to make more informed decisions.

From antiquity, humans have used conversations to share ideas, enhance cooperation and develop societies. In the future, machines may transform and enhance human-to-human conversations, making them more seamless, creative and productive.

1 The Future of Retail 2018 - Walker Sands Communications

2 Ray L. Birdwhistell, Kinesics and Context: Essays on Body Motion Communication

TT05

Spatial Computing

Technology to capture real world environments has become commonplace, allowing the replication of objects and space in precise size and positional relationship. Generated environments with augmented information will become an entirely new medium, transforming business and individual perception.

The Emergence of Spatial Computing

Spatial computing is a technology that allows people to extend the advantages of a computer beyond the scope of a screen by using surrounding spatial environments. With this technology, computer graphics (CGs) are projected in real space. These are not images to see, but rather a space into which one can enter and use information that the computer provides. Use of this technology is growing at an unprecedented rate, yet its advantages are difficult for people to comprehend fully without actually experiencing it.

Although spatial computing is still in its infancy, anyone can experience it using an augmented reality head-mounted display (AR-HMD) or a smartphone. It consists of simple computer graphics of real objects at actual size that get overlaid on the real world as if they were actually present. As a result, one can walk around and see these computer-generated objects, and even touch them.

A typical application for this technology is spatial planning. The conventional way to conduct ex-ante confirmation of a delivery route, installation location and workspace for large equipment uses a 2D diagram or a small-scale model. A superior alternative uses spatial computing to display a full-size CG of the equipment in the actual factory space. Workers can view inside the factory to visually check the equipment from all angles. This not only reduces time and effort but prevents errors due to unforeseen circumstances.

Another common example of spatial computing use is to provide work assistance by including more observational information. For example, to inspect a finished piece of an industrial product on the factory floor an inspector visually compares the product with the procedure book. Spatial computing, on the other hand, can clearly show the key points of inspection and how to use pertinent inspection tools by superimposing CGs directly on the actual object. Spatial computing used in medical surgery, where the image gained from a test can be superimposed accurately on a patient's body, is another beneficial use of this technology.

Enhancement of Real-Scale Data

A critical factor when using spatial computing is the accurate size and positioning of the object shown via CG in real space. For the purposes of this white paper, "3D data" refers to the real-scale data that indicates the dimensions of an object, while a "3D map" indicates the real-scale space and position in which the object is placed.

Large-scale, dedicated equipment is needed to digitize objects and space. For example, detailed 3D data of a person is produced by placing a person wearing markers in a dome-like facility with multiple, carefully positioned cameras. Huge numbers of photographs are then synthesized through data processing to generate 3D data. Although smaller devices have been developed, part of the task still requires the knowledge of experts.

However, AI has made creating 3D data far easier. Object estimation technology that leverages machine learning generates 3D data based on several photographs taken of an object. Better still, the entire undertaking can be completed on a smartphone. The development of technology that constructs high-quality 3D data using fewer photographs and cameras is only now showing promise.

The emergence of technology that lets individual users use their own devices to conveniently generate 3D data and 3D maps is fueling the popularization of spatial computing. Low-cost, high-accuracy sensors, which have been rapidly developed over the past ten years, are making the generation of 3D maps more convenient. Some head-mounted displays can now convert a space to a 3D map immediately in front of a user. Currently, resultant 3D maps are rather crude, consisting of simple lines. Yet they are sufficient to understand the size and position of an object placed in a room.

One can only imagine the impact of integrating 3D maps generated by individuals with those in the public domain. For instance, companies involved in self-driving cars have launched a platform that integrates detailed road information collected by running vehicles. 3D maps that contain the size and position information of every building, sidewalk, tree and street sign in cities where people move about will be pasted onto high-definition satellite images. Based on these, the direction in which to go is shown in the streetscape in front of the user, while the signs of restaurants and bars display their customers' evaluations and word-of-mouth messages. As real-scale 3D maps continue to become available, the value of spatial computing will increase dramatically.

Balancing Between the Two Realms

The convenience of spatial computing will progress further when CGs reach photo quality. This value will be particularly evident in the marketing of products and experiences. Imagine having the ability to try on clothes, visualizing yourself dressed in different locations and backgrounds, such as a business meeting in an office or at a cocktail party at a social venue.

The current state of spatial computing, however, is far from photorealistic. This is because today's limited computer performance gives priority to real-time characteristics over photo-real attributes. For instance, when spatial computing displays movement of a person's head and eyes, a delay time of over 0.02 seconds gives users a sense of discomfort. This precedence given to real-time attributes results in a compromise in image quality.

To overcome this issue, technologies have been proposed to lighten the processing loads of head-mounted displays. One promising technology called "foveated rendering" has proved highly effective. It displays in high definition only the parts of an image on which the human eye is focused. In addition, other trials are using photorealistic images generated on a cloud via a minimum-delay 5G network. The perfection of such technologies that provide photo quality in real time will catapult spatial computing to the next level.

Expansion of Spatial Computing

Spatial computing is garnering increased attention and is generating great enthusiasm within the development community. Companies that are aggressively promoting digital business are paying enormous attention to this technology in order to transform customer experiences. One firm spent several years successfully providing spatial computing technology on smartphones as a standard feature. Others are releasing innovative head-mounted displays and creating spatial computing in the cloud. In addition, technology such as spacial anchors and rendering are making possible multi-user, spatially aware mixed realty experiences, which in turn can harness the power of collective wisdom. The competition is increasing, particularly in the area of customer contact.

Behaviors of people themselves will also likely change due to future advances in spatial computing. Consider a day when instead of manually entering words to search for a topic on a smartphone, a person will simply look at a thing or location. For a generation that takes instant search results for granted, the way they view the world each day will change with spatial computing.

TT06

Quantum Leap in IT Infrastructure

Demands for accelerating system processing continues. Domain-specific development infrastructures and entirely new computers are appearing. Consequently, the ability to select a high-speed infrastructure that enhances performance is now a requirement for businesses.

IT Infrastructure Key to Business Strategy

The competitive advantage of digital businesses hinges on the strategic selection of IT infrastructure. Previously, the performance of applications determined competitiveness and general-purpose processors were the mainstream. Now things have changed. New applications have emerged based on deep learning that cannot be handled by existing processors. In addition, mobile has become the most important point of customer contact. As a result, businesses require service design, which often places the greatest priority on customer experience.

The ability to use AI will undoubtedly have a powerful influence on the relative merits of modern business. The essential component behind today's IT infrastructure is the graphics processing unit (GPU), which provides the massive parallel processing capability to support AI and deep learning. Businesses everywhere have implemented these high-speed processors at scale to support innovation, while others have developed unique AI processors to gain a competitive edge.

Smartphones are now the most critical direct point of contact with customers for all kinds of digital businesses. High-speed, low-power consumption mobile processors determine the operability, usable biometrics, high-resolution photo quality and longer battery life of smartphones. The smartphone industry has matured considerably making it possible for firms to assemble standard parts and enter the market relatively easily. Existing companies vying for the largest market share, like those shipping 200 million units annually, or new entrants in emerging markets are focusing on developing proprietary processors with distinct features to offer unique functions.

Mobility is without a doubt the next realm of competition for digital businesses. For example, certain functions are required for situation recognition and decision-making in autonomous driving technology, such as sensor fusion, deep learning and cloud connection. IT infrastructure that can support these functions close to where it is required even under severe conditions and with low power usage, is collectively referred to as edge processing. Businesses are betting their future supremacy on acquiring or developing a processor that

underpins an organizational plan. Consequently, an increasing number of businesses consider IT infrastructure as part of core strategy. The need to develop one's own hardware has arisen from the pursuit of improvements in points of customer contact in a bid for a competitive advantage in service.

Processor Acceleration Through Miniaturization

Miniaturization of semiconductor manufacturing has helped accelerate the processor, which is the core of IT infrastructure. This technology has also downsized transistors embedded on processors, which has allowed businesses to benefit from shorter processing time and power savings without modifying software assets. Miniaturization is continuing, with gate lengths now down to 7 nm in the latest manufacturing process. Gate lengths of 5 nm are even within reach by using extreme ultraviolet lithography (EUV).

The technology, however, driving continuous miniaturization over many years has grown complex and progress has slowed. In fact, only one firm was able to ship products with gate lengths reduced to 7 nm in 2018. Others fell behind schedule in supplying such products or dropped out of the market. Technological complexity and cost pressures are likely to inhibit further rapid miniaturization. Business strategies premised on ever-faster IT infrastructure will therefore require reevaluation.

Acceleration Realized Through Specialization

As miniaturization becomes a less likely solution for further acceleration, purpose-specific processors have come to the forefront. These processors focus on specific functions to reach higher speeds and efficiency when combined with specialized software. One example is an AI-specialized processor. New processors have emerged embedded with algorithms specializing in AI learning or inference that limit functions depending on the framework. Since offering high-speed, high-efficiency AI will help innovate service and add value to the use of cloud environments, major cloud vendors are presently developing original AI processors.

Edge processors are also being used for various purposes such as autonomous driving and module-connected robots for collaborative sensing and work. Purpose-specific processors offer a solution to the issue of rapid obsolescence in digital businesses. For instance, processors that respond flexibly to changes have been proposed for machine-learning applications. These processors adapt and reconfigure to changes in learning frameworks. Such innovation is expected to continue using recently developed open source processors.

Acceleration from Quantum Computers

Current computers are still unable to operate near the capacity of the human brain. For example, supercomputers require more than five minutes to simulate one minute of the human brain's neural network, which is roughly 0.5% of the entire brain's capacity. Accordingly, computers capable of high-speed processing of massive data, such as for fluid dynamics and drug discovery, continue to be in high demand.

Quantum computers could transcend the performance of current computers as they use quantum mechanics to perform massive, parallel processing functions through quantum gates. Numerous businesses have invested heavily and have launched development efforts in commercializing the quantum gate method, which is expected to have versatile qualities. Meanwhile, other vendors have invested in the quantum annealing[1] method, which specializes in optimizing combinations.

Of note is that operation of these new computers will contrast starkly from the way computers are coded today, making it difficult for present-day computer engineers and programmers to use. Moreover, quantum computers will be custom-designed for individual business needs, and cross-section use will likely require massive revisions in formula development. The same limitation applies to purpose-specific processors. The use of such infrastructure will require a high-quality development environment and a specialized software development community. As a result, not all companies will be able to pursue this strategy. In short, today's business has entered an age requiring an even more strategic selection of IT infrastructure and development partners.

1 Quantum annealing is a metaheuristic for finding the global minimum of a given objective over a given set of candidate solutions (candidate states), by a process using quantum fluctuations.

TT07

Personal Data for the Digital Era

Massive leaks are precipitating a global imperative to protect information. While personal data is becoming a security focal point, its value mandates active utilization by broad distribution. Balancing the utilization and protection of personal data has become a prerequisite for economic development.

Unintended Use of Personal Data

Numerous devices are continuously storing traces of data. A tremendous amount of personal data continues to be accumulated in the digital world ranging from name, date of birth, GPS, web view histories and other attributes. Data logs are then transmitted from our devices via the internet to improve and personalize services that companies provide.

Personal data is now extremely valuable and cyberattacks targeting it show no sign of abating. Hundreds of millions of items of personal information have leaked from businesses, including major hotel chains and marketing companies. In excess of 2.2 billion email addresses and passwords have been revealed and published on the dark web. The abusive use and collection of data by companies has also attracted tremendous attention. For example, one social networking service was suspected of sharing unauthorized data with a consulting company that allegedly used it to manipulate public opinion. Both companies have been subjected to heavy criticism. There was another case where a smartphone application, which was distributed without going through the proper review process, collected all types of data from young users. Because of its high value, personal data continues to be targeted for abuse by multiple players.

Global Protection of Personal Data

Large-scale information leaks caused by cyberattackers and undesirable collection and misuse of information by companies have resulted in a global trend to protect information. For example, the General Data Protection Regulation (GDPR) adopted by the European Union (EU) was enforced in May 2018. This regulation grants individuals the right to control their own data and stipulates a variety of rules for companies that hold and use data. To comply with this regulation, companies need to adhere to multiple measures such as a clear consent for the collection and use of data, appropriate measures for security management and data erasure after a request. The EU is also examining ePrivacy Regulation. Privacy protection is becoming active in other regions. In the United States, the State of California passed the California Consumer Privacy Act and is now preparing for its enforcement in 2020. In addition, many Asian countries are working on similar legislation development.

Technological measures for data protection are becoming increasingly important. Ongoing efforts are striving to improve the quality of data protection via multiple approaches including the use of AI and camouflage against attacks on supply chains. Individuals are starting to look for ways to protect their own data. For example, the number of people who use search engines that never track histories is on the rise, increasing by 50% compared to the previous year. Services and functions that meet the demands of users who wish to value privacy, such as DNS that does not record IP addresses and web browsers that emphasize anonymity, will likely also expand in the future.

Data Distribution to Maximize Value

As data protection efforts accelerate, work is also underway to build an environment where proper personal data distribution maximizes its value. For instance, discussions are proceeding toward the establishment of a management and distribution system focusing on individuals instead of data-holding companies. Personal data stores, where individuals manage their own data, are becoming a reality in Europe and other parts of the world. In Japan, a system called the Information Bank is now in its preparatory stage. In this model, an information bank is entrusted with the data of individuals based on an agreement and provides such data to third parties only with approval. After the transaction, the bank pays the individuals a fee and profits result.

It is also essential to be able to easily move the information that each company holds to distribute data to maximize its value. Some IT companies are working on the unification of data exchange formats between services. Although different services may have inconsistent forms and storage methods, conforming to a uniform rule during data movement will likely streamline its distribution and enhance its value.

Technological advancements are widening the range of data distribution. Using anonymization, which processes personal data to disassociate it from the individual, it is possible to automatically extract and anonymize even proper nouns from unstructured data such as text written in a natural language. Using this, even medical documents and meeting minutes are expected to become distributable. In addition, secure computation, which enables the processing of encrypted data without decoding is also enabling the safe use of sensitive data.

Balancing Protection & Distribution

While data distribution is attracting significant attention, excessive sharing of data could cause future conflicts. For instance, some regions of the world are seeing the emergence of a credit score service that calculates the creditworthiness of individual customers based on transaction and behavior histories. However, the ranking of individuals through the use of such data can also be considered a material infringement of privacy or a discriminatory practice. Businesses must find as part of their activities practices that are acceptable to users as the owners of the data.

One way to solve this issue is with on-device AI. The advancement in AI chips that can be mounted on smartphones and on-device learning methods are enabling closed processing within a device. On-device processing does not require data transmission to a cloud, so companies do not view or manage data. As a result, on-device processing is predicted to generate services that are significantly more personalized and secure.

It is equally important to think about what type of data is really necessary. One streaming service does not use personal data such as nationality, gender or age to improve the accuracy of its recommendations. It analyzes user attributes based on viewing histories and hours of use instead, leading to more users and sales. Other companies have started to calculate patterns based on vast amounts of behavioral data for targeting purposes. In the future, new perspectives that defy existing benchmarks and conventions may become the first step in acquiring customer trust and expanding service. When the competing concepts of both protection and distribution of personal data reaches an equilibrium, new innovations will be developed rapidly driving further economic growth.

TT08

Service Design Innovation

A design process that fosters services via continuous improvement builds a foundation for corporate competitiveness. Successful businesses use the flexibility of IT to take advantage of change through service design. Services, now the main driver of business change, will transform business operations.

Digital Accelerated Service Design

Service design optimizes the customer experience by defining the customer and weaving together various components of business operation. The customer experience involves not only direct points of contact such as advertisements, stores, displays, services and payments, but also back-office functions and activities. Improving the customer experience requires measurement of customer reactions at each of these crucial points of contact, and finding comprehensive ways to improve them. This is easier said than done, especially at large-scale enterprises.

Digital has made service design the vanguard of competitiveness. Smartphones are now ubiquitous and serve as a direct-to-consumer (D2C) channel for business. Digital businesses not only offer services through this channel but also collect detailed feedback from customers in real time. Electronic Commerce (EC) is a case in point. In EC, digital covers almost all points of customer contact and businesses use service design on the D2C channel to provide service, collect feedback and make continuous improvements. EC smartphone apps use huge amounts of consumer purchasing data to create tailored product recommendations. Purchased products are input into a logistics system and delivered efficiently and on time. Customer satisfaction is enhanced through design for one. This is a service that tailors services to individual customers as if attended by an experience concierge. For example, when customers place an item in their shopping cart but hesitate to buy, the reason behind this decision is analyzed carefully so that the customer experience can be enhanced. Upgrades are made immediately through software revisions and results of these improvements are once again extracted and evaluated in a continuous loop called DesignOps.

Continuous improvement through service design boosts customer satisfaction, attracts more clients and augments competitiveness. The numbers speak for themselves. EC account for 13% of all retail sales and shows signs of further growth.[1]

Service Design Expands the Business Realm

Service design is expanding into many different areas, and businesses that use a service design strategy have overwhelmed peers that rely on legacy models. Examples include product sales, content sales such as video/music, services such as online travel, and regulated services such as online sales of prescription drugs. Subscription services have been made possible through digital systems and D2C channels. FinTech ventures are also using service design to revolutionize customer experience through investment apps with intuitive UI offered free of charge, and financial planning apps that can organize multiple loans and debts plus provide more personalized services. Businesses have expanded via numerous new approaches: automation and streamlining of back-end operations, re-organizing complex business practices based on the customer's perspective, utilizing massive data to improve customer targeting, and re-designing business schemes through design for one.

Digital technologies have been the primary driver behind service design. In addition, cloud technologies enable this process by increasing flexibility within this improvement loop and by supporting rapid changes in strategy.

Service Design Drives Increased Competition

As the effectiveness of service design becomes clear, competition has intensified between digital business firms. The competition is basically a race to secure more of the disposable time of customers on D2C channels. Digital businesses are destined to compete for face time since there are numerous types of businesses on D2C platforms, but a limited number of channels. The amount of disposable time secured through a channel is equivalent to how much data can be obtained. In other words, securing users' disposable time is the driver of continuous improvement in service design.

Smartphones and smartphone apps currently occupy D2C channels. The time spent on these channels allocated to a particular service is now decisive for the future development of any business. Digital enterprises with different profit infrastructures such as EC, advertisements, on-demand media and hardware all compete for a slice of face time spent on D2C channels. In order to secure a higher share, businesses are integrating functions on chat apps covering entertainment, EC, payments, mutual funds and social credit scores. Moves to gain share of disposable time on new D2C channels (which serve as alternatives to smartphones) are also noteworthy. Possible future channels include smart speakers that use voice UI, smartwatches that help monitor individual health and compact/lightweight head-mounted display goggles that use spatial computing.

Future Developments in Service Design

Service design is being applied to companies that connect the digital with the real world. For example, several stores have opened in North America without cash registers, which offer a customer experience similar to EC in purchasing daily necessities. These operations possess the potential to translate the same characteristics as digital businesses into brick and mortar stores such as speed of opening and scaling.

Service design is also expected to transform transportation. Drivers will become redundant if autonomous vehicles can transport people and luggage. Ridesharing and other digital businesses that have already disrupted the customer experience in other areas are now moving into the center of the transportation industry. As a proof point, the first company to publicly announce a self-driving taxi was not a traditional carmaker but a digital business. The company's demo video trumpeted its creation of the most desirable mode of transportation for users, not the self-driving technology itself. In this sense, it can be called service design.

Many issues remain with this business model. Data cannot be derived from the physical handling of objects, quality cannot be digitized and some tasks cannot yet be automated. This presents a challenge for digital businesses to transcend the digital realm into the real world. Advancements continue to be made based on trial and error, such as in EC shipping, fitting clothes and accessories, and management and logistics in the sales of perishable goods. Overcoming these challenges in the physical world is key to a successful digital business, but failures remain commonplace.

The fact that digital businesses are struggling with physical world problems also shows that traditional firms still have the potential to leverage competitive edge accumulated in the physical world. For example, one automaker is revamping its business around service design. This strategy combines the characteristics of a traditional business, i.e., strenuously accumulated production technologies, long-term customer satisfaction and quality that generates a sense of assurance to users, with the customer experience derived from the flexibility and speed of digital technologies. Traditional manufacturers have accumulated technologies from the result of steadfast service design that can be used to their advantage, although they may still lack the degree of design needed to match the speed of digital businesses. In summary, conventional businesses have the option to steer in a given direction to adapt to significant changes in market conditions, while calmly acquiring any competencies that they lack.

1 Internet Trends Report 2018

Case Studies

Key initiatives of our innovation at NTT DATA in relation to technology trend described in NTT DATA Technology Foresight.

Leveraging AI for Process Efficiency

TT01 Socially Accepted AI

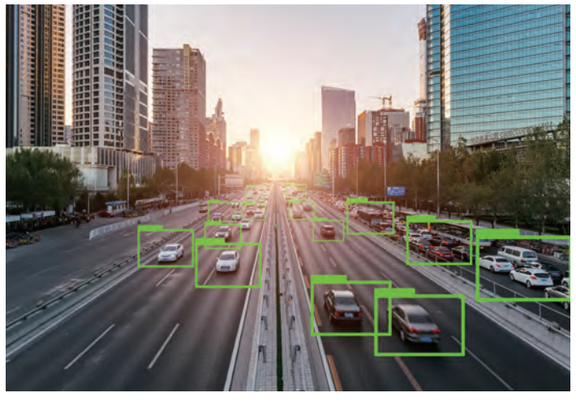
NTT DATA conducted a demonstration test using AI-based object recognition for X-ray inspection at the Customs Department of a country. The objective was to analyze whether illegal objects were present in luggage or containers and if the contents matched what was stated on the customs declaration form.

In a separate client demonstration, we used AI to detect the sections within an application form most likely to contain false statements or descriptions. With pre-evaluation provided by the AI, inspectors were more effective at performing verification processes.

In the future we will see great benefit to our society, as we combine AI skills like these to augment and enhance human activities.

Performance Improvement of AI through Automatic Data Generation

TT02 Usable Augmented Data



Although the accuracy of AI image recognition has improved, it remains difficult to keep accuracy high, particularly in cases with unusual conditions such as the recognition of a car in snow, fog or a dark area. This occurs due to insufficient learning data for unusual conditions. NTT DATA is researching and developing a means to improve AI's recognition performance automatically. For example, if the AI decides that the degree of confidence is low for particular results, this technology analyzes the characteristics of the image or video, then generates image or video data that contain what is required.

NTT DATA will incorporate this function into an AI learning system under development, to reduce barriers and expand possible uses for AI.

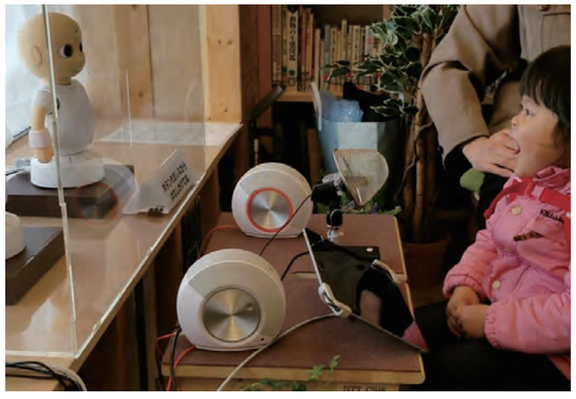
AI-Diagnosis Solution Aids Physicians in Disease Detection

TT03 Digital Life Science

NTT DATA is developing an AI-assisted image diagnosis solution to help radiologists analyze the medical images of patients. Radiologists spend many hours scanning hundreds of tomographic images as well as 3D data captured by CTs and MRIs, looking for signs of serious disease. To support this effort, NTT DATA is developing a service using deep learning technology to analyze patient images and indicate the most likely locations of disease. To further improve efficiency, the system will also take into consideration the difference between the diseases based on climate and lifestyle of each country. Together with our global group companies, we are creating this valuable service for countries around the world.

Multiple Robots Deliver More Natural Human Conversation

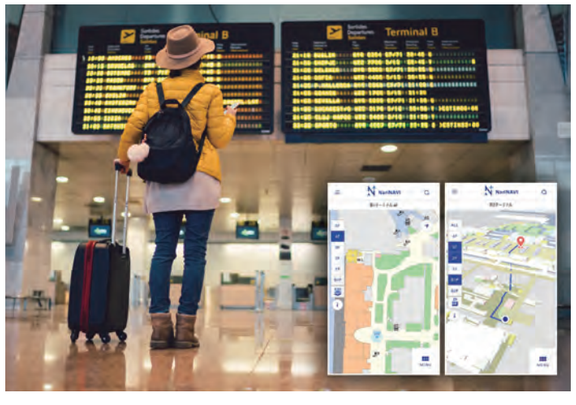
TT04 Natural Interaction



To improve human-to-AI interaction, Nippon Telegraph and Telephone Corporation (NTT) is developing a chat control technology using collaboration between multiple robots. More natural human-to-AI interaction entails not only answering questions, but also engaging with people through more conversational communications. When a robot provides an unnatural response, it breaks the continuity of the conversation. To minimize this, chat control technology uses a second robot to continue the conversation based on a related topic or using a similar sentence it identifies in listening to the human speak. Through this technology we aim to create a more natural human-to-robot conversational experience.

Real Time Navigation Improves Transit at Narita Airport

TT05 Spatial Computing



NTT DATA developed NariNAVI®, an airport navigation application that provides highly accurate, real time location information to the terminals of Narita International Airport.

The solution uses earth magnetism positioning and beacons to enable the display of highly accurate indoor location information, an area where GPS signals cannot reach.

The application also uses a 2.5D mapping platform technology to display the multi-floor facility. As a result, users can easily recognize their position from a bird's-eye view, ensuring smooth transit through a complex airport. NTT DATA plans to leverage similar techniques for future navigation applications.

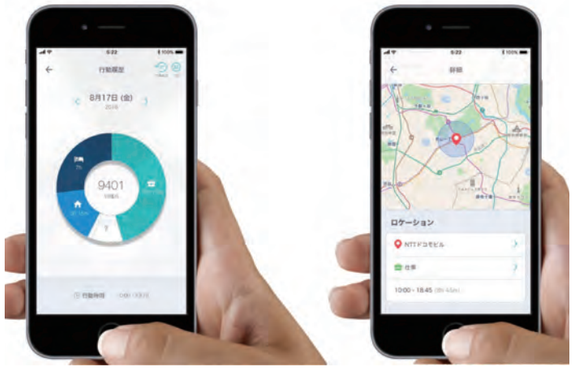
Quantum Computing Lab Analyzes Use Cases to Speed Processes

TT06 Quantum Leap in IT Infrastructure

NTT DATA offers a quantum computer lab service, which analyzes how to best use quantum computing based on its characteristics and the client's specific business issues. Quantum computers are often expected to perform high-speed calculation of problems that have otherwise been difficult to achieve. The service leverages the quantum annealing method, which is best suited for mathematical optimization problems. NTT DATA provides a one-stop solution that includes issue analysis, device selection, solution validation for a real device and implementation. Our R&D team is working to identify the ideal business applications for leveraging this substantial calculation power.

Demonstration Testing of Personal Data Trust Platform

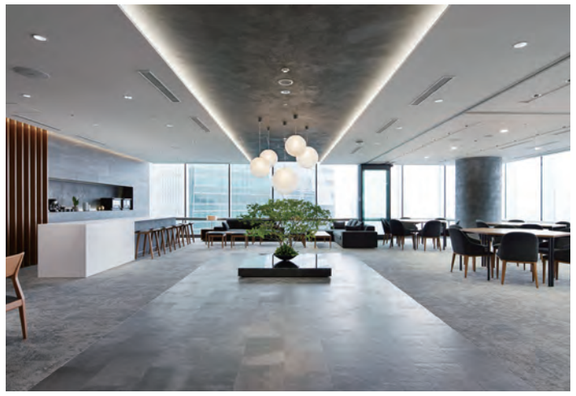
TT07 Personal Data for the Digital Era



NTT DATA participated in the proof-of-concept beta testing of "DPRIME (provisional name)," Mitsubishi UFJ Trust and Banking Corporation's information trust platform. This demonstration test compiled personal data (i.e., behavioral, walking and financial data) to analyze from cross-sectional, multilateral and chronological viewpoints. This enabled the identification of potential issues when individuals manage and use their own personal data. In addition, we corroborated the appropriate value of the personal data with the price and terms that are acceptable for a specific individual who voluntarily provides access to their data. NTT DATA will continue to support the secure and safe distribution of personal data.

Design Studio Optimizes Customer Experiences

TT08 Service Design Innovation



NTT DATA launched the Fluid Experience Design Studio AQUAIR™ ("the studio"), which offers unique approaches and environments to optimize a customer experience driven digital business. We prototype a real environment, using virtual reality to analyze client behavior patterns and feelings, and for demonstration testing within a temporary, popup store. NTT DATA integrates its ten global design studios to share lessons learned and human resources. Based on this approach, NTT DATA has designed a new service to assist clients in developing digital-driven businesses focusing on user experiences – from planning and demonstration to marketing activities.

Looking ahead: Technology trends driving business innovation.

More than ever, the importance of applying innovative technologies for sustainable growth is accelerating.

NTT DATA Technology Foresight presents information society and technology trends.

By analyzing major issues within politics, the economy, society and technology, we hope to deliver business innovation for our clients and society.

Tsuyoshi Kitani

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