

Data – Powering Digitalization and AI

Data is the key to the future. But in order to unlock that future, you need to know how to use that key. The promise of artificial intelligence (AI) and analytics is that these tools will allow us to exploit the wealth of data that is available today and the even greater amounts of data that will be available in the future. At NEC, we have been a leading force driving the digital transformation, devising new AI technologies to help users take advantage of the explosion in data. By incorporating that technology in new and innovative products and services, as well as in human resources, and by zeroing in on specific social issues, we are able to offer resources that will help our customer solve those issues. AI technology is expected to advance rapidly in the years to come with a focus on the three basic frameworks that form the foundation for AI solutions – visualization, analysis, and prescription. At the same time, more efforts will be made to make AI more accountable, especially in terms of processing transparency and social acceptability. Finally, rapid development of small data learning technology will enable companies to more easily exploit deep learning technology and quickly get smart, practical fast-learning solutions up and running.

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1. Introduction

NEC was founded exactly 120 years ago in 1899. Since then, we have pushed forward relentlessly, developing cutting-edge technologies targeted at helping solve the most pressing social issues of the era. Back in 1899, one of the greatest technological challenges the world faced was the need to establish reliable and efficient international communications networks. We played a significant role in the completion of telephone networks that heralded the modern era of communications and since that time we have continued to develop new systems that revolve around our core communication technologies, while evolving into related information processing fields such as research and development of communication satellites and data transmission.

Our first foray into the field of artificial intelligence (AI) began with work on handwriting recognition systems for automatic postal code reading and sorting machines, which would later evolve into image recognition and Bio-IDiom biometric authentication. More recently, we released a suite of advanced AI technologies called NEC the WISE, which can process an unprecedented amount

of data by taking advantage of the explosive expansion of processing power in CPUs/GPUs, accompanied by virtually unlimited storage and the proliferation of high-speed networks. Our AI technologies, as well as our IoT and security technologies, are paving the way for a brighter and more prosperous future where people can live lives of abundance in a world that is safer, more secure, more efficient, and more equal.

2. NEC's Commitment to the Ethical Integration of AI and Society

Increasingly sophisticated AI systems will be deployed to solve and manage various social issues, thereby ushering in fundamental change in our society. Effectively managing this transition to ensure that AI is used in a beneficial and human-centric way is key to the ethical integration of AI and society. To this end, in addition to pressing forward with the development of AI technologies and AI-based solutions, we are committed to developing and providing mechanisms and educational content to facilitate the continuous training of people able to proficiently handle AI.

Having already set forth basic guidelines to prevent discrimination through the use of AI in “NEC Group AI and Human Rights Principles”, we are now working to develop procedures to respond to new challenges expected to occur when AI is implemented. To ameliorate the current shortage of AI experts, we have established the NEC Academy for AI and are setting up various programs to support ongoing human resource training in AI, not only for ourselves, but for business and industry more broadly.

Taken together, we are confident that these efforts will help accelerate safe and effective integration of AI in our society.

3. NEC’s Commitment to Creating Social Value through AI

NEC’s customers range across a wide spectrum of sectors and industries, from governmental and public to financial, distribution, manufacturing, and communications. Naturally, then, the issues our customers face are multi-faceted and the AI-based solutions we offer must be flexible enough to cope with the very different challenges faced by individual customers. This means that our commitment to creating social value by leveraging AI must also reflect the diversity of customer needs rather than focusing solely on a single technology and targeting specific themes only. With this in mind, we have built intra-company structures that will allow us to create basic frameworks for AI and analytics that can be adapted to different requirements and speed up the development of appropriate AI-based products and services. In this issue of NEC Technical Journal, we will highlight some examples of how we have used our AI technology to solve various issues and describe the processes of social value creation that we used to achieve those solutions (Fig. 1).

4. NEC’s Commitment to Basic AI Technology Development

AI performance has been growing exponentially over the past few years, driven by rapid progress in ICT and deep learning. AI is already being implemented in various fields, and is widely expected to power economic growth in the decades to come. But how exactly will AI technology evolve?

In order to predict the future of AI technology, it is useful to think of how we can reproduce our intellectual abilities artificially. Human intellectual activity can be interpreted as a series of processes that begin by observing and understanding real-world objects, then intellectualizing and judging them, and finally taking an action based on the results of that intellectual activity (Fig. 2).

AI follows a similar intellectual process, running on computers and operating on data. Research and development of AI has been underway around the world for quite some time, with NEC pioneering the field. For more than half a century, we have been developing AI-related technologies and are responsible for many groundbreaking innovations in the field. Today, we have one of the world’s largest collections of advanced AI technologies¹⁾, including face recognition and heterogeneous mixture learning. To reflect the process of human intellectual activity, NEC has developed world-leading AI technology in the domains of visualization, analysis, and prescription and will continue AI-related R&D using these three basic frameworks (Fig. 3).

While the technologies in these three domains are frequently utilized independently, the optimal approach would be to deploy these technologies and functions in an integrated manner so that they can work together to create a virtuous cycle that generates ever more advanced and intelligent functions and services, propelling

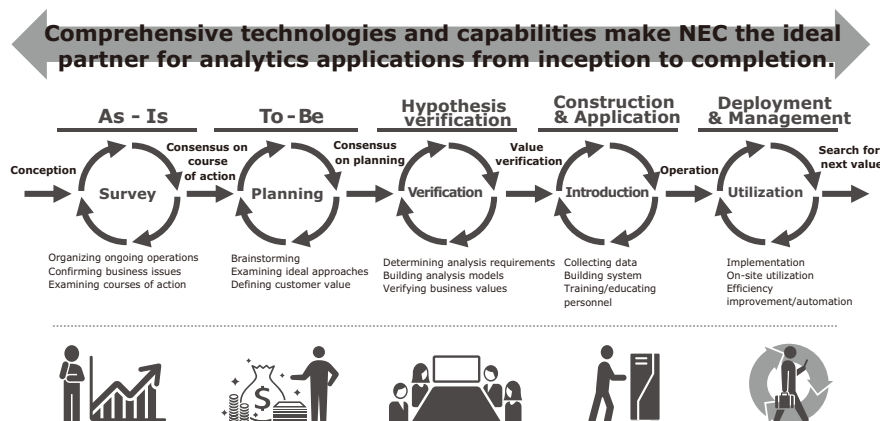


Fig. 1 Harnessing the power of AI and analytics.

customer value to higher levels. To accomplish this goal, the development of system platforms that facilitate the organic cooperation and functioning of AI technologies is critical. Similarly, a data management environment that transcends organizational barriers must be created in which data can be securely collected and accumulated. One example of this that has attracted a lot of interest is digital transformation (DX), which digitally models real-world sites while deploying various AI functions that operate in concert on AI platform to make possible high-level prediction and optimization control (Fig. 4).

At NEC, we are taking two complementary approaches to the development and evolution of AI technology. The first is a goal-oriented approach to problem solving such as safe city planning and quality control. The focus here is on generating massive efficiencies based on products and services that operate automatically and autonomously by utilizing machine learning and other technologies. In terms of technological development, this approach aims at increased precision with extended visualization coverage, increased analysis speed, and more robust algorithms to cope with disruptions. The

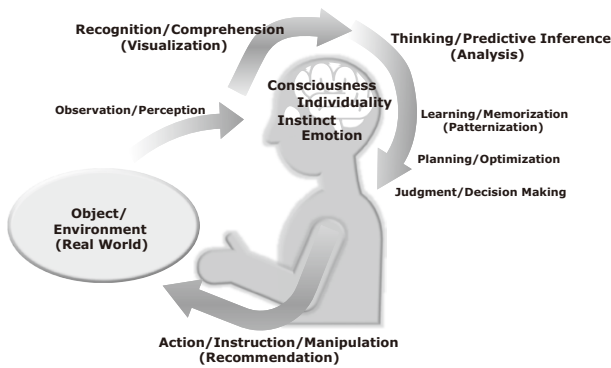


Fig. 2 Human intellectual activity.

second approach focuses on problems where goals are less obvious. These are problems that demand the kind of flexibility that normally requires human reasoning such as managerial judgment, personal care, and new product development. Bringing AI into the equation poses a greater challenge than it does in the first approach. It requires taking knowledge to a higher dimension by, for instance, facilitating cooperation between AI and humans and enabling AI to propose effective suggestions to help humans solve problems. Specifically, an AI system designed to handle the more complicated problems and knowledge — normally the responsibility of human experts — would need to include machine learning that can handle causality and graphically structured data. We are also now working on the development of technology that can learn human intentions.

5. Creating the Future – What’s Next for AI?

AI is everywhere, powering a multi-billion-dollar industry and changing our lives in innumerable ways. Yet despite its ubiquity, AI suffers from some major limitations that make it difficult to realize AI’s full potential. Two problems in particular stand out — the first is the “black box problem”, the second is the fact that deep learning is dependent on massive amounts of training data.

The black box problem arises from the inherent characteristics of deep learning technology. The term derives from the fact that AI’s decision-making process is opaque to us. We cannot predict how an AI program (model) will behave once it has been trained on a data set, nor, when it makes a decision or offers a recommendation, can we know how it arrived at its response. Current deep learning technology cannot guarantee the accuracy of output and operation. Nor can it promise stable performance when data is input that contains

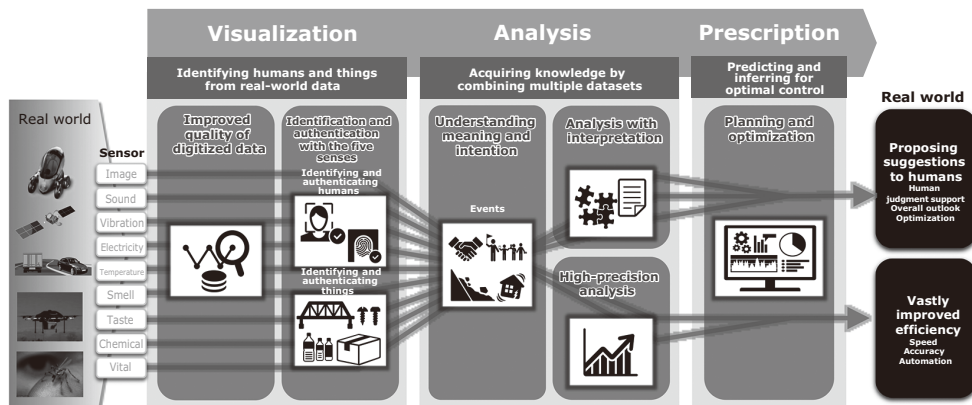


Fig. 3 Creating social value by combining data with multiple technologies to aim at creation of social value.

variations or errors or for totally unknown input. To address the issues of how black box decisions are made, a new field of AI called Explainable AI (XAI) is emerging. XAI focuses on creating AI systems that feature processing transparency and social acceptability.

Processing transparency means that humans can easily understand how an AI system reached its conclusions and that there is a clear cause-and-effect relationship between input and output as well as high reproducibility. NEC has developed various white box type machine learning technologies which — unlike deep learning — produce results that can easily be interpreted and comprehended. Even when deep learning is used, we try to make high performance and processing accountability compatible with each other by using deep learning in a way that enables us to specify behaviors and characteristics — for example, by only applying it to designing sections of feature values. We have also begun to conduct preliminary research and work in the area of making it easier to understand AI’s behaviors and conclusions, enabling human users to participate in AI decisions and stop and control them as necessary. Current efforts include building new data structures such as graphic structures and time-series data, as well as visualization of trained models.

Social acceptability is a more complex issue. It refers to instilling in AI systems a better sense of human knowledge and social boundaries. Without this, public trust and acceptance of AI will be limited. Let’s assume that an AI model that incorporates a social acceptability framework learns data that could result in it making decisions. If the decisions are inappropriate in terms of laws or customs or are biased, the AI could warn the user that the actions it is recommending may not be appropriate in terms of social acceptability. Alternatively, the AI could directly modify the model itself in order to assure that it only arrived at socially appropriate results. NEC’s research in this direction aims to develop systems

that incorporate human knowledge and social understanding supported by cutting-edge AI technologies such as logical inference and intention learning.

The other big problem holding back AI is the massive amount of training data required for deep learning to achieve practical levels of performance. For example, image recognition usually requires at least 1,000 images for one recognition target. Ideally, it would require tens of thousands of images with correct labels. This is clearly impractical if not impossible at the initial stage of inspection. A more effective approach would be to launch an early version of an AI model with as little training data as possible, gradually improving precision and performance over time by continually learning and collecting training data through trial operations. This can be done using small data learning technology, which is designed to achieve levels of precision and performance sufficient for practical use using very small amounts of training data — from one-half to one-tenth of the conventional amount, or in some cases, even about one-hundredth. Theoretically, training data can be virtually created by directing other training data and already trained models to this technology. Some of this technology is already at the level of practical use and we have started applying it to our machine learning products.

6. Conclusion

More than just a buzzword, AI is the predominant technology of the future. With AI, we can build a sophisticated world in which people can live brighter and more affluent lives. At NEC, we are confident that AI will gradually mature, integrating into society as a practical technology that effectively responds to real-world situations and works closely with humans to produce optimal, socially acceptable results. As NEC’s AI technology continues to evolve, we are committed to ensuring that it does so in a way that is transparent, secure, and socially responsible.

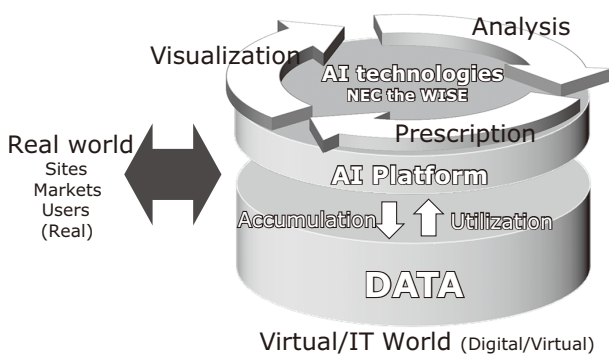


Fig. 4 Building a digital transformation (DX) system.

Reference

- 1) NEC Press Release: NEC Face Recognition Technology Ranks First in NIST Accuracy Testing, October 2019 https://www.nec.com/en/press/201910/global_20191003_01.html

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NEC's Efforts Toward Social Applications of AI

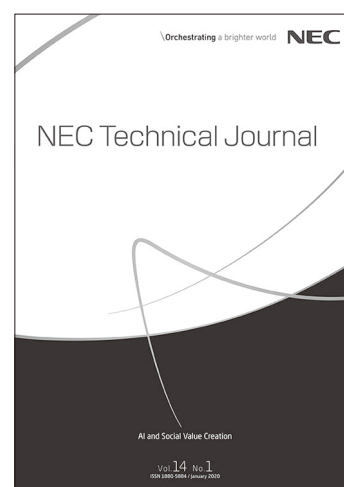
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