The Near Future of Artificial Intelligence

Research and development efforts in the field of artificial intelligence (AI) have lately produced startling outcomes. AI research modeling the human brain has developed important technologies, and has overcome significant barriers. Given that it is on course to surpass human abilities, what stance should we adopt towards AI as it continues its evolution?

MyVision

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How will Artificial Intelligence Affect Humanity in the Near Future?

Coming into application in a range of areas, AI will offer support to humanity, but at the same time will also encroach on human activity.

How will AI change our lives and our societies five to ten years into the future?

Is the evolution of AI a boon to humanity, or does it represent a threat? What are the issues that we should be preparing for at present?

In this issue of *My Vision*, we seek opinions concerning these questions from specialists engaged in the research and development of artificial intelligence and wearable computers, an IT industry researcher, and a researcher in the fields of science and technology.

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White collar workers will be replaced by AI

Noriko Arai

Director, National Institute of Informatics,
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As part of an ongoing project seeking to determine whether artificial intelligence (AI) can pass The University of Tokyo entrance examination, the National Institute of Informatics had AI take dummy entrance exams over a two-year period. The AI achieved standard scores of around 50 in each subject, exceeding the norm for humans attempting the tests. The AI's results in subjects emphasizing memorization, such as world history and Japanese history, were comparatively high, and the results of the study suggested that an appropriate selection of subjects would give it an 80% chance of passing the entrance exams of 80% of Japan's private universities.

The achievement of standard scores of 53 was within the predicted range. At this level, if white collar workers were replaced by AI in the future, around 30% of current staff would be replaced. The society of the near future will differ depending on whether the AI's standard score exceeds 55 or approaches 60. Whatever the outcome, large companies will be presented with two choices. One will be to protect their employees, but as a result lose their international competitiveness. The other will be to have the bulk of their white collar duties performed by AI. The latter choice will enable them to reduce the cost of general duties, financial management procedures, etc.

If spending on education does not produce the creativity demanded of human employees, and the best that can be expected for a student is employment in a position that will be replaced by AI, household investment in higher education may decline, leading to a lower rate of advancement to higher study. How should we design Japan in order to adapt to the evolution of AI?

The advanced AI methodology deep learning is something like a statistical principal component analysis, and will not ultimately enable the AI to arrive at an understanding of meaning. Even if we increase the standard score achieved by AI, it is impossible to consider that they will ever be capable of rational judgment exceeding human capabilities. But without being able to predict the future, risks are also mounting. What will AI be capable of, and what will it be unable to do? The issue is to maintain a focus on the real nature of these issues while seeking a design as a nation that will ensure diversity and minimize risk. ■

Dr. Arai directs an NII project which is attempting to enable AI to pass The University of Tokyo entrance examination. She is engaged in considering the future of humanity in view of progress in AI technologies. Dr. Arai has also had a long-term interest in mathematics education for school students at all levels.

Cultivate individual ability rather than mounting huge projects

Masakazu Kobayashi

Research Fellow, KDDI Research Institute, Inc.

Research on artificial intelligence commenced in the 1950s. Initial methods eventually reached their limits, and from the end of the 1980s, research entered a period of stagnation termed the "AI Winter." However, the field began to revive in 2006, with the full-scale importation of the outcomes of brain science research into AI research. The method called "deep learning" was developed, and there were dramatic advances in technologies such as image recognition and voice recognition, which form the foundation for AI.

The introduction of AI can transform existing products into new, intelligent products. This will have an incalculable effect on industry. It will revivify industries that have matured and stagnated. Expectations are high for a wide range of fields of industry. Products which already incorporate AI include cleaning robots, smart TVs, and virtual assistants on smartphones. Products which will incorporate AI in the

future include self-driving vehicles, drones, and nursing robots.

Amid these developments, Japanese universities and companies missed their chance to engage with deep learning from its appearance in 2006. Japan has now begun a hurried process of catching up, for example through the establishment of research institutes dedicated to artificial intelligence. However, if this is simply window dressing, it will ultimately represent a waste of taxpayers' money. More than research institutes and enormous projects with huge budgets, the first priority is for individual researchers to cultivate a broad vision and clear insight.

We must not forget, also, that artificial intelligence has a negative dimension. For example, if weapons such as missiles were equipped with AI, in the future they would become able to decide on their own targets. This type of scenario is almost upon us. The UN is working to formulate a treaty banning the use of AI in weapons, but it will not possess binding force. The only path open to us is for each of us to maintain constant vigilance, and to apply restrictions when necessary. ■

> Mr. Kobayashi conducts research in the areas of advanced science and IT. He is particularly recognized for his farsightedness in perceiving the direction of the IT industry, and for making cogent proposals to Japanese companies based on his discernment.

Japan can be a winner in the race for AI
Yutaka Matsuo

Associate Professor, Graduate School of Engineering,
The University of Tokyo

We hear the argument that artificial intelligence may be a threat to humanity, but actually AI is only one of the elements making up human society. It is, innately, a subsystem of society. When a goal has been set, AI will implement an appropriate means for its realization. Artificial intelligence will be used as a tool by human society; humans will not be enslaved by artificial intelligence. Even if the capacities of AI exceed those of the human brain, it is difficult to imagine the type of technological singularity represented by the creation of an AI by another AI.

At present, the circumstances of AI resemble the situation when the Internet made its appearance in 1995, and as was the case then, in the near future new key players and platformers will come to the fore in the world of AI. It is important that we rapidly and accurately predict these developments. When image recognition and other individual technologies are functioning at a high level, there will be a considerable upheaval in different sectors of industry.

Facing a declining birth rate and an aging population, Japan has little cause for optimism for the future. AI, however, has the potential to be the nation's trump card in increasing productivity and reviving its industrial competitiveness. Japan's need for AI is surely that much greater than that of a country possessing abundant labor power. AI will be an extraordinary industrial power, and Japan must be a winner in the battle for its development.

Japan has a comparatively large membership of scientific societies at around 3,000 people (5,000 in the case of international scientific societies). Because AI is algorithm-based, language does not represent a barrier. If we were also able to cultivate a new generation of engineers who are perfectly familiar with "deep learning," the latest AI technology, we could catch up in around two years. Japan possesses advantages that offer chances; responded to appropriately, these could enable us to win out in the AI competition. It is essential that we sketch out a vision of a new society based on AI, and work to realize that vision. ■

> Professor Matsuo works at the forefront of AI research, seeking to realize major breakthroughs via new AI-related technologies including deep learning. His fields of specialization are Web mining, big data analysis, and artificial intelligence.

Towards the enhancement of human intelligence through wearable technologies
Masahiko Tsukamoto

Professor, Graduate School of Engineering, Kobe University

Looking ahead five years, everyone will use wearable terminals; people will connect to the Internet to obtain various types of information, and computers will collect and analyze information on people. We will no longer be confined to our rooms working at our computers, but will be able to get out into the air and engage in healthy activities, making our lifestyles richer and more convenient. Our lives will probably be even more reliant on these technologies than they are on smartphones today.

Artificial intelligence will be generally used, and will be extremely useful in analyzing the information collected from wearable devices and stored in the cloud. AI will enable wearable devices to be of real assistance in our lives, offering their users more intelligent support.

Rather than allowing artificial intelligence to develop exclusively on servers, as something separate from humanity, it will be more meaningful to encourage its development via wearable devices, situating it under the control of human intelligence. The intelligence of AI will increase rapidly in the future. If this increase in intelligence occurs under human control, enabling humans to increase their own abilities, then surely it will be possible for us to put up a degree of resistance to the opposite scenario, the domination of AI over humanity. In deciding whether or not to use wearable devices, however, we will have to bear in mind factors such as the loss of equality between people, and threats to privacy.

At present, computers are adequately able to reproduce the emotional, conceptual, and intuitive abilities of humans, and I believe that it will only be a small step until they surpass human abilities. There is also the possibility that AI might become malevolent. Because of this, it is important that we should envision potential future problems that may manifest when we consider how to employ wearable devices. It will be essential to enhance our technologies in order to ensure that we can use AI under human control. ■

> With a focus on wearable computing, Professor Tsukamoto conducts research on directions for next-generation computers from a variety of perspectives, including systems and applications. Since 2001, he has worn wearable devices on a daily basis, earning him the nickname "the evangelist of wearable computing."

AI is already overtaking us
Osamu Sakura

Dean, Interfaculty Initiative in Information Studies,
The University of Tokyo

Artificial intelligence is bringing a third wave of evolution on another level to previous evolutionary waves. AI are already able to defeat humans at *shogi*, and the time seems near when they will also win at *go*. Traditionally, the creation of a relationship of complementary coexistence between the areas in which humans are most capable and the areas in which machines are most capable has been the important focus. Today, however, machines have become able to decide for themselves what they will learn, making it difficult to erect clear divisions between the human and machine domains.

What we must consider, then, is just what it means that machines

exceed humans and AI surpasses human capabilities. Many technologies exceed human capacities. Cars are faster than humans; planes are able to fly. Computers display overwhelming speed and accuracy. Humanity has always developed through the use of artificial inventions. In a broad sense, law, the state, and our various other systems are artificial inventions. Given this, rather than viewing AI as something new and special and adopting a defensive stance, surely we should attempt to develop a reasonably amicable relationship with the technology.

It is quite likely that artificial intelligence will outstrip human abilities. Attempting to prevent this is futile; we have already been outstripped in the physical domain. We should view this as a consequence of the entire history of technological evolution, and not immediately take AI as being inimical to humanity. We can derive lessons in this respect from the industrial revolution and other events in the past.

There is, however, a risk that some trivial mistake involving AI might result in a major incident. The worst outcome would be that we remain unsure what to do and unclear in our values and vision for the future, being either swept up by the technology, or alternatively rejecting it outright. We must look toward the creation of a consensus throughout society as a whole regarding the relationship between humanity and machines. ■

Professor Sakura investigates the relationship between contemporary society and science and technology. Specializing in "evolutionary ecology informatics," Professor Sakura brings a wide range of subjects within his focus around an axis of evolutionary biology theory, including the history of biological science, theoretical approaches to science and technology, and the theory of scientific communication.

About this Issue

The Near Future of Artificial Intelligence

Recently, we have seen Softbank's offerings of its "Pepper" robot units sell out within minutes. The Roomba cleaning robots, nursing robots, automotive technologies: All of these are among other devices incorporating artificial intelligence. AI is already part of our daily lives.

There have been several "AI booms" up to the present, but these were all transient phenomena. Now, however, the development of the Internet and the dramatic increase in computer processing speeds have helped to realize "deep learning," which incorporates the outcomes of high-volume machine learning and brain science. With this, a major technological barrier has been overcome, and there are great expectations for future developments. The idea that AI will surpass human intelligence in the near future (2045), has ignited international debate.

Up to the present, the vision of artificial intelligence surpassing humanity has generated a mixture of optimism - as the beginning of a new era for humanity - and pessimism - as the beginning of the end of humanity. Most of the experts who offer their opinion in this issue of *My Vision* appear to calmly accept the situation surrounding the development of AI. One expresses the view that because AI does not possess instinct, it cannot surpass humanity. However, whether they adopt this perspective or not, our interviewees are agreed that AI will have an overwhelming impact on industry and society, and that society must prepare itself for the development of AI.

Artificial intelligence is currently one of NIRA's research topics, and we requested the leader of this research project, Professor Shumpei Kumon of Tama University, to act as our interviewer for this issue. Professor Kumon considers the two scenarios for artificial intelligence in NIRA's Opinion Paper No. 17, published in July 2015. Please refer to the Opinion Paper for that discussion.

Reiko Kanda, NIRA Executive Vice President