

Technotalk

Human-friendly AI that Learns from Life

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The use of artificial intelligence (AI) is growing, with applications that range from big data analytics to marketing and self-driving vehicles. It is anticipated that new possibilities for business will open up through the combination of AI with large quantities of data acquired from real life, including human behavior and operating conditions from a variety of equipment. Anticipating such developments, Hitachi was among the first to work on the development and deployment of general-purpose AI. Through this work, Hitachi is seeking to revolutionize business and society using AI solutions based on proprietary technology and concepts. Today, we invited Kazuto Ataka of Yahoo Japan Corporation, a leading evangelist for new AI, and engaged in a discussion with Kazuo Yano, who directs general-purpose AI research at Hitachi, concerning the shape of the future in which AI and people will co-exist.

A Number of Problems for AI

Yano: Currently, interest in AI is growing around the world. Having had much to say about AI and data analysis, drawing on a background of knowledge from neuroscience, how do you view recent developments in the field of AI?

Ataka: As I see it, there are three problems. The first is the misdirected hype surrounding the subject that, lacking an understanding of what AI actually is, has engulfed it in fear-mongering and exaggeration. Certain ways of thinking specific to Japanese people, inspired by robot anime and a fondness for science fiction, may play a part in this.

The second is a lack of understanding of the genuine changes brought about by the synergy of AI and data. It is almost certain that many different types of work based on the processing of information, including the assessment and classification of information, analysis and prediction, and manual work, will be automated at speeds tens of thousands of times faster than human beings are capable of. I wonder how many people genuinely appreciate the incredible power of this.

The third problem is that, perhaps influenced by these preconceptions and lack of understanding, and despite Japan having many AI-related technologies, I have a strong sense that we are lagging behind the advanced economies of Europe and America, who have a more realistic view of things and where the pace of development is accelerating.

Yano: Having discussed AI in many different places, I too, have become strongly aware of the

preconceptions you are talking about. The greatest problem, which is not limited only to Japan, is the view that humans and AI are in conflict. This is the biggest mistake.

Ataka: That's right. And this is despite AI being for the benefit of humans.

Yano: The real conflict is not with machines but with other humans. It is a battle between the traditional approach of only learning from one's own experience or from those around oneself, and the new approach of utilizing computing power to learn systematically from all available data. This is because it typically makes no sense to compare the speed of a human to that of a car, or the extent of your knowledge to that of an Internet search engine.

Ataka: Because you can't win comparisons like that.

Yano: A search engine is in truth an agglomeration of AIs. In the same way, machines will always win out in certain areas. Nevertheless, there are also things that only we humans can do. I believe we need to increase the number of people who view AI in terms of this correct framework.

Ataka: I completely agree, and for this reason we are engaged in public education initiatives. On the other hand, when you consider the relationship with robotics, there is also a danger that we will build something that will be antagonistic to humans. What are your thoughts on this?

Yano: I believe that ethics will become more important. However, if you think about it, all tools are capable of both good and bad uses, and creating a technology that is absolutely incapable of being misused is an impossible objective. If you consider AI as a tool, then

it is no exception. That said, there will be a need to impose some form of restrictions.

Ataka: As with genetic engineering, there is a need for measures that govern the technology. The Boston-based Future of Life Institute, a research support organization, is involved in activities such as supporting research into AI that will contribute to the future of humanity and looking into the risks that AI poses. The Future of Humanity Institute at the University of Oxford headed by philosopher Nick Bostrom is studying the impact that AI will have on humanity and how to control it. I have also heard of similar institutions being established at The Massachusetts Institute of Technology (MIT) and the University of California, Berkeley. I believe we also need to be doing something similar in Japan.

Yano: What is needed are places where people from all walks of life can come together to debate the subject, including those with no involvement in AI research. More fundamentally, it may also be that we need to be thinking about mechanisms to prevent the misuse of technology or runaway research.

AI Should Mimic the Immune System

Ataka: While it is difficult to impose restrictions that do not impede progress, there is a concern that, unless debate gets underway and we start thinking about guidelines soon, it will be too late. For example, a more pressing problem than the misuse of robots may be the use of AI in cyber-attacks.

Yano: But by the same token, can't AI also be used as a defense? In practice, consultations along these lines are already in progress. Might it not be possible to build AIs that act as an immune system, protecting against unauthorized activities?

Ataka: Constantly retuning itself to provide protection. That is quite a good fit with how AI works.

Yano: So you agree that there is a great deal of similarity between an AI and an immune system?

Ataka: Very much so. They both learn from a complex environment.

Yano: The immune system deals with unknown threats yet is based on a finite number of genes. It works by partially accepting the unknown entity and acquiring the means of manufacturing antibodies from the invader itself so that it can be defeated the next time it is encountered. It operates autonomously on a completely different level than consciousness and the brain and is eminently systematic. While the brain is frequently used as a comparison in the discussion of AI, it seems to me that we should be trying to mimic the immune system.

Ataka: This extremely high capacity for learning is not the only thing that the immune system has in common with the central nervous system (CNS), which I originally studied. The proteins expressed on membranes are also similar. In fact, there are a number of proteins that are specifically expressed in the CNS and immune systems.

Yano: No doubt there is some significance to that. Along with the brain, I also see the immune system and evolution as examples of knowledge-based activity by living organisms. This makes me think that AI research should pay more attention to mechanisms from these two fields.

Ataka: That is a good idea. Although a life scientist myself, I have just learned something new about living organisms from a physicist, Dr. Yano (laughs).

Yano: I wouldn't think of trying to teach you that. Despite being a physicist, I have a fascination with life and the study of it, and accordingly I have paid a lot of attention to biology, especially the biology of the human body, in my AI research. The question of how we can get AI to understand human happiness and use it to enhance that happiness is one of my main research topics, and a key factor in assessing people's happiness is their bodily rhythms.

For the last 10 years we have been working on research in which we analyze people's activities by using wearable nametag sensors to record their movements in the form of three-dimensional acceleration data. In doing so, we have identified characteristic patterns of bodily movement that correlate strongly with people's happiness. Looking at fluctuations in the duration and frequency of activity, we find that in groups with high happiness these fluctuations have a natural distribution, by which we mean that there is diversity in people's movements. Through this analysis we have developed the ability to numerically calculate a happiness index from group activity data.

From various studies into variations among living organisms, it can be seen that there is a commonality in the rhythm of variation between people and mice, and even with flies. Furthermore, if mice or flies are genetically modified to exhibit characteristics of depression, the same disruptions to rhythm can be seen in them as in people with symptoms of depression. While we tend to think of happiness as something that belongs to the field of psychology, I believe it is linked to more fundamental aspects of biology.

Ataka: Behaviors (actions) you say? I believe our emotions and thinking follow from our behaviors (actions). From a neuroscience perspective, nerve

cells tend to die if they are not part of a network, which is to say, if not connected to inputs and outputs. Considering this, it may be that the body does not exist for the benefit of the nervous system, rather it is the body that is central.

Adult AIs, Child AIs, and Gut AIs

Yano: That's why we focus on acceleration. We want to look at the outputs. Naturally, the ease of making all-encompassing measurements is also a factor.

Ataka: If you look at the outputs, then the brain is not all that important. This is a very bold idea.

Yano: The brain is like a router. Not that routing isn't important.

Ataka: "The brain is a router" – that makes a quotable phrase.

Yano: What is important about routers is that different tasks are performed through the same paths. We talk

about people as "having guts" or having a "gut feeling." In English, the meanings of the word "guts" include grit and determination. In this way, it seems to me that what an internal organ essential to our survival and a decision-making system have in common are a gut-like nervous system and a router.

Ataka: I agree. That's because the nervous system for the gut region is as well developed as the central nervous system. In other words, the gut is also a brain.

Yano: The gut, too, is a brain.

Ataka: It seems that pursuing the brain of the gut is one path open to AI research in Japan.

Yano: That's right. That's because we at least have a capacity for "belly talk" (in Japanese idiom, the ability to communicate through one's attitude rather than through words).

Ataka: That's right. In the Ministry of Economy, Trade and Industry (METI) council on which I sit, we are currently debating the possibilities and challenges of AI. A major topic in this discussion relates to what Dr. Yutaka Matsuo of the University of Tokyo calls "adult AIs" (information processing systems) and "child AIs" (motor systems). This is the view that Japan should leave adult AIs to major international players and instead take advantage of our position as a world leader in manufacturing to focus on child AIs that can be used in construction, factory, and other workplaces. As I see it, adult AIs correspond to the cerebral cortex and child AIs correspond to the cerebellum. If the ingenuity and manufacturing excellence of the Japanese people are equated to the cerebellum, then it is natural for us to direct our efforts toward the cerebellum AI. The idea of a gut AI has never arisen.

Yano: Whatever it is that determines our gut feelings, it is a decisive force. That people around the time of the Meiji Restoration who didn't know much English could engage with people from America and Europe on an equal footing and be respected was likely because of their gutsiness and the fact that this is a universal that goes beyond language. I believe that AIs that make decisions on a larger scale rather than competing on speed of detailed decision making may be an option that plays to Japan's strengths.

Ataka: The pitcher Hideo Nomo was playing major league baseball when I was a graduate student in the US, and I remember how a friend in my class commented on how dignified he appeared. Despite not being able to speak English, he conveyed an impression of having guts. Still, how do you go about developing a gutsy AI? **Yano:** Perhaps it is something we could work on together (laughs).

Ataka: It is certainly a very creative subject. It is completely different from the usual concept of AI.



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Joined McKinsey & Company after completing the Master's program at the University of Tokyo in Biophysics & Biochemistry. After working there for four and half years, he entered the Interdepartmental Neuroscience Program at Yale, where he earned a Ph.D. in Spring 2001. After postdoctoral studies, he came back to Japan to re-join McKinsey at the end of 2001. As a core member of its Marketing and Sales Practice for the Asia-Pacific region, he was involved with brand rebuilding and product and business development for a wide range of sectors. In September of 2008, he moved to Yahoo. Following positions as Director of COO office and Head of Data, Research and Strategy, he took up his current appointment in July of 2012. In addition to resolving business strategy issues and promoting large-scale partnership projects, he is in charge of the Marketing Insight and Intelligence Department, the Yahoo! Big Data Report, and company-wide strategy including data utilization. Director of the Japan DataScientist Society. Director of the Japanese Society of Applied Statistics. Among his literary works is "Issue Driven – A Simple Essence of Intellectual Works" (Eiji Press).

Being Issue Driven

Yano: While deep learning, for example, has huge potential, most real-world problems cannot be solved by the weight of data and computing power alone. What are needed are techniques that can deal with business and other parts of society from a different angle.

Ataka: In this respect, while it may sound odd coming from a director of The Japan DataScientist Society, there are also aspects of the data science boom itself that make me concerned. While data processing techniques are clearly powerful when seeking to solve problems in business, how to pose the problem is so much more crucial, rather than how to apply specific techniques or logic.

Yano: Which is the same idea you expressed in your book, "Issue Driven – A Simple Essence of Intellectual Works." Most of the time when we fail it is because we have misunderstood the issues.

Ataka: It is the same with me. The title of the book was directed at myself (laughs). The majority of business decisions do not require particularly advanced data science. In this data-driven era, without having a clear understanding of the issues, namely what questions we are seeking to answer, we will end up going in the wrong direction. In achieving this, it is vital to get the basics right, meaning collecting clean data and making appropriate comparisons in accordance with the issues. I am concerned that inflated expectations for data science are spreading through a failure to understand this point.

Yano: In that case, it is important to aim for AIs that are capable of general-purpose application in a variety of systems and that can respond proactively and autonomously to all sorts of threats and other changes, just like the immune system.

Ataka: I agree. Along with gutsy AI there is also immune system AI. I will suggest at the next council meeting that Japan should compete on the basis of the cerebellum, the gut, and the immune system (laughs). However, what is the current situation in Japan? Are we ready to join the international battle for AI development?

Yano: In the context of our earlier discussion of issues, I believe we Japanese need to hone, not only our skills for solving specific problems, but also those for formulating good problems and concepts. Rather than insights on their own, we need to strengthen our ability to draw on specific experiences and formulate concepts and problems, and I believe we can do so.

The formulation of good problems is in some ways related to AI. We spoke about the immune system, and I see AI as a tool for controlling an

unknown world. Because we have no knowledge of unknown problems, there is nothing to be gained by repeating past practice. If you think about it in terms of a hierarchical structure where, in the past, a mechanism existed whereby a particular phenomenon occurred and that mechanism in turn was caused by a higher level mechanism, then you realize that structure exists in the unknown, that a way exists for finding a solution, and that each piece of information contains a hundred meanings. I believe that AIs capable of doing this in an extremely systematic manner will prove to be partners that will help people by building an as-yet-unknown future.

Ataka: But if AIs did this for us, would there be anything left for people to do?

Yano: You can also view it as a means for better utilizing the abilities we have. In relation to the happiness index we talked about earlier, what we found in a project at a call center was that the overall happiness of the group was influenced by the level of conversation during breaks, and that the order



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Joined Hitachi, Ltd. in 1984. In 1993, he achieved the world's first successful operation of single-electron memory at room temperature. Since 2004, he has taken the lead in the collection and utilization of big data. His papers have been cited 2500 times, and he has 350 patent applications. The wearable sensor he developed has been described by the Harvard Business Review as a "historic wearable device." His literary work, "Invisible Hand of Data: The Rule for People, Organizations, and Society Uncovered by Wearable Sensors" (Soshisha Publishing), was elected one of BookVinegar's 2014 10 Best Business Books. Dr. Yano has a doctorate in engineering, he is an IEEE Fellow, a visiting professor at the Tokyo Institute of Technology, and a member of the Ministry of Education, Culture, Sports, Science and Technology's Information Science and Technology Committee. He has been awarded many international awards, including the 2007 MBE Erice Prize, and Best Paper at the 2012 International Conference on Social Informatics.



rate was 34% higher on days with above average happiness compared to below-average days. The ability of people to put their skills to use is influenced by small changes in their surroundings.

One thing that was deeply interesting was that there was no correlation at all between days with high order rates and days with a high proportion of staff with high order rate performance in the data from the previous half year. You cannot build a strong team from number four batters alone. The performance of a team is not the sum of the individual skills of its members. Rather, there are other factors that come into play. One example is that there are people who, despite their own results being poor, act to bring out the best in those around them. Although we naturally assume these subtle intra-group relationships must exist, thanks to data and AI, this is the first time we have been able to visualize them. If we think only about logic, all of these subtle effects tend to get swept away.

Ataka: And yet the truth was present in the data.

Evolving AI for Exploring an Unknown World

Yano: Hitachi underwent a corporate reorganization this April. Following the Research & Development Division, which had already moved to a new structure that focuses on collaborative creation with customers, this involved a major transformation in which the business units switched from the previous product-based company structure to a customer-oriented

and service-based structure. Within this structure, instead of selling AIs as such, our philosophy is to supply services that utilize AIs to help overcome a wide variety of customer challenges. Finally, please tell me your views on this relationship between AIs and services.

Ataka: In the case of interpersonal services, for example, I see the greatest potential for data and AI analysis coming at the stage of learning about the background and latent needs of customers. In a healthcare context, this would be when conducting a diagnosis prior to writing a prescription. As for the subsequent marketing and actual service delivery (or prescription writing and treatment), because having people do this work generates more value, I see AI as serving a backup role, supporting people on the frontline.

Elsewhere, data analysis can provide support for work that in the past has been more of an art, such as optimizing logistics or the physical layout of equipment, etc. While these are back-end services, they should enable improvements on the front end through AI and people thinking together. While it is difficult to simulate models that involve the interaction of multiple systems, I see scope for AI in fields such as business dynamics.

Yano: I see change as being the essence of services. This includes both changes over time and changes due to people or circumstances. In this sense, you can describe AI as a tool for dramatically reducing the cost of adapting to these changes. It is the generation of wealth and elimination of inequalities in the world



through the resulting fundamental improvements in productivity that are the ultimate goal of AI research.

Ataka: Nevertheless, the view persists that this is something that only large corporations can achieve.

Yano: I don't believe this myself. Whereas the options for responding to change under past business logic have been limited, data and AI open up a much larger range of options. It can also be said that the process of earning a profit equates to finding a place for oneself in the network of economic transactions that is of benefit to everyone. It is my hope that the use of AI to look at things in ways that are different from those of the past will enable a greater number of companies to find such a place for themselves.

Ataka: Finding their own niche, in other words.

Yano: And isn't that just another way of saying evolution?

Ataka: That's right. In ecological models, the opening up of a new niche leads to the emergence of new species.

Yano: Evolutionary AI supports this process.

Ataka: Yes, I see the connection. I hope we can make ongoing progress on research into evolutionary AI that will open up unknown worlds.

Yano: Our aim is to create human-friendly AIs that work with us to create a happy future. Thank you for your time today.