



How will “democratization of artificial intelligence” change the future of radiologists?

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Abstract

The “democratization of AI” is progressing, and it is becoming an era when anyone can utilize AI. What kind of radiologists are new generation radiologists suitable for the AI era? The first is maintaining a broad perspective regarding healthcare in its entirety. Next, it is necessary to study the basic knowledge and latest information concerning AI and possess the latest knowledge concerning modalities such as CT/MRI and imaging information systems. Finally, it is important for radiologists to not forget the viewpoint of patient-centered healthcare. It is an urgent task to nurture human resources by realizing such a healthcare AI education program to educate radiologists at an early stage. If we can evolve to become radiologists suitable for the AI era, AI will likely be our ally more than ever and healthcare will progress dramatically. As we approach the “democratization of AI,” it is becoming an era in which all radiologists must learn AI as they learn statistics.

Keywords Democratization · Artificial Intelligence · Medicine · Radiology · Radiologist

Introduction

“This might be rather rude, but since I heard that radiologists and pathologists will be replaced by artificial intelligence (AI) in the future, I will not become a radiologist.” This was a response I received when I spoke about the appeal of diagnostic imaging to medical students this January and recommended radiology as a specialty. It reminded me of the shocking words I heard from Dr. Geoffrey E. Hinton in 2016: “I think if you work as a radiologist you are like the coyote that’s already over the edge of the cliff, but hasn’t realize there’s no ground underneath. It is just completely obvious

that within five years, deep learning is going to do better than radiologist, because it is going to be able to obtain a lot more experience. It might be 10 years, but we got plenty of radiologists already. We should stop training radiologists.” It is said that AI will take many jobs from humans. Is AI an enemy or ally of radiologists? There is an expression, “democratization of AI,” which encompasses the idea that in a society, “everyone can utilize AI technology.” As the era of AI approaches, what should radiologists do to make AI their ally?

Recent progress in AI and ICT

The speed at which AI and information and communication technology (ICT) have progressed in recent years is astonishing. New technologies that seemed far off in the future are rapidly becoming reality (Fig. 1). Wearable devices, such as heart rate monitors, pedometers, activity monitors, sphygmomanometers, and ECG monitors, are sold for home use at affordable prices. Voice-activated AI that is “always connected” and robot phones are also commercially available for the general public. If you watch YouTube videos of robots, such as Robot Kitchen from Moley [1] and Atlas from Boston Dynamics [2], you can see that both robots are already available for application

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Exponential Evolution of Technology

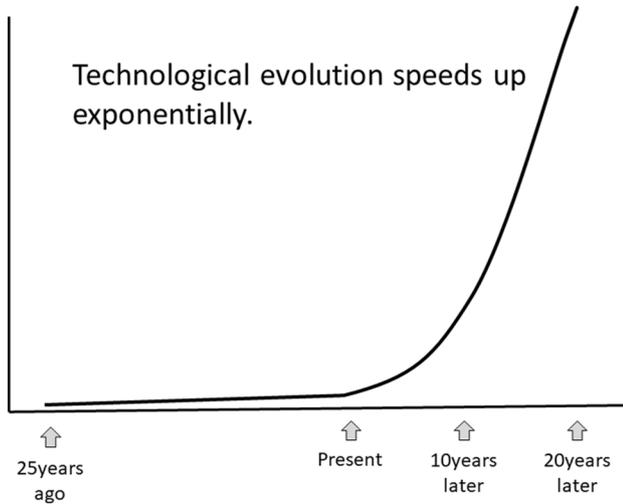


Fig. 1 Exponential evolution of technology

in the general public. Various cutting-edge technologies, such as AI (machine learning/deep learning), big data, Internet of Things/Everything/Human, Virtual/Augmented/Mixed Reality, robotics, wearable devices, and 5G, are widely used daily and will be integrated into the medical field (Fig. 2).

Utilization of AI in medical care

I believe that you are all aware that the number of academic papers on AI is rapidly increasing in the field of medicine [3]. A 2017 paper published in Nature reported that GoogLeNet, which is provided by Google to the public, was shockingly able to diagnose melanoma from photographs of skin lesions at the same level of diagnostic performance as dermatologists, indicating the possibility of an inexpensive smartphone application [4]. Furthermore, a paper published this year reported that AI had in fact performed better than dermatologists [5]. There have also been reports on AI performing better than pathologists in the diagnosis of lymph node metastasis of breast cancer [6] and in the prediction of cardiovascular risk factors using fundus photography [7].

Regardless of our involvement, it is inevitable that AI will be used in daily tasks. It is said that “In the future, AI will definitely play a part in diagnostic and therapeutic policy decisions, and as medicine dramatically progresses, physicians will gain time and mental leeway, which will allow physicians to go back to the original purpose of ‘healing people’.” Regarding AI as a device to support the diagnoses of physicians due to the risk of AI making a misdiagnosis in diagnosis, the government announced the other day its policy to stipulate the principle that “physicians will be responsible for final diagnosis and treatment policy decisions and responsibilities” in the Medical Practitioners’ Act. This is good news; nevertheless, we cannot let our guard down. In April of this year, the U.S. FDA granted the first approval to sell AI medical devices that are able to diagnose retinal

Fig. 2 Medical ICT (information and communication technology) utilization

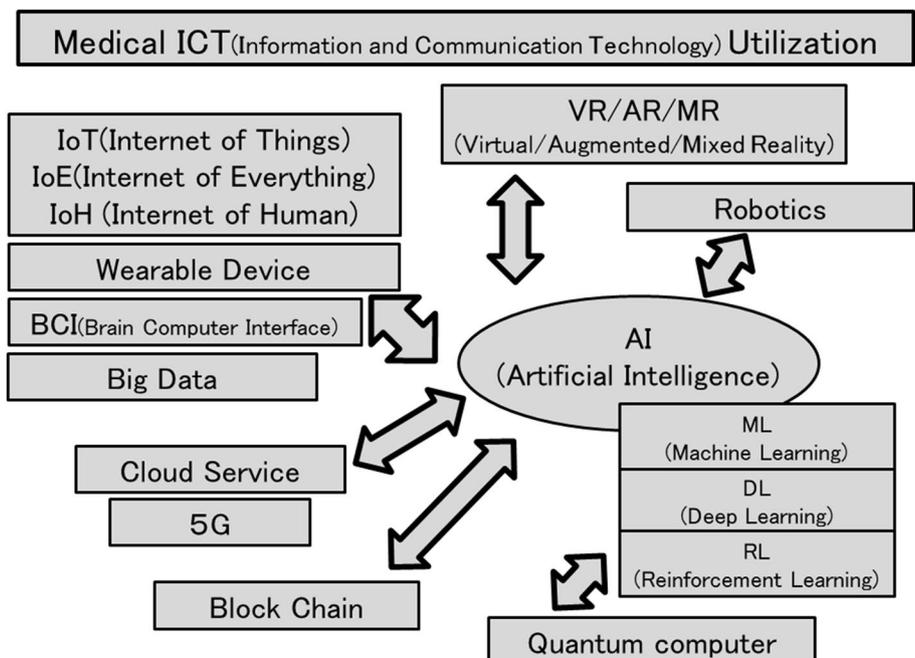


Table 1 Role of AI in diagnostic imaging

Image quality improvement
Image generation
Automatic detection
Segmentation
Classification
Regression (measurement/ quantification)
Appropriate workflow
Automatic creation of reports

lesions without a physician [8]. We must actively become involved and control the directionality of AI development, such that it suits daily tasks performed in Japan.

The use of AI in diagnostic imaging is classified as follows: (1) improvement of image quality; (2) image generation; (3) automatic detection; (4) segmentation; (5) classification; (6) regression analysis (measurement and quantification); (7) optimization of work flow; and (8) automatic preparation of reports (Table 1). There are academic papers on AI that are being published one after another on topics such as the detection of pneumonia from simple chest images [9, 10], detection and improved work flow of cerebral hemorrhaging and infarction from head CTs [11, 12], detection of cerebral aneurysm from head MRIs [13], assessment of skeletal maturity on pediatric hand radiographs [14], differentiation of brain and liver tumor [15, 16], determination of necessity for contrast imaging with bone and soft tissue MRIs [17], classification of fibrosis in liver CTs [18], image reconstruction [19], the ability of deep learning to classify head MRI sequences [20], and MR-based synthetic CT generation [21]. AI, deep learning with a convolutional neural network, is gaining attention recently for its high performance in image recognition [22]. Imaging diagnosis is becoming increasingly complicated [23]; therefore, it is indispensable for radiologists to use positively AI in clinical practice.

Democratization of AI

The "democratization of AI" is progressing, and it is becoming an era when anyone can utilize AI. There is a case in which individual farmers developed a cucumber sorting machines that utilized AI with the library that companies provide free of charge at a cost of 20,000 yen [24]. In fact, many papers introduced in the previous section used the library (learning framework) free of charge provided by various companies or cloud platform at low costs, which is a method anyone can use (Table 2). This is an era wherein one does not have to be an AI expert to develop applications that utilize medical AI technology. In recent years, there

Table 2 "Democratization of AI" machine learning platform

Cloud platform	Library (learning framework):
Microsoft Azure	Caffe (yahoo)/Caffe2(Facebook)
IBM Bluemix Cloud: Watson AI	Chainer (Preferred Networks)
Google Cloud Platform (GCP)	TensorFlow (Google)
Amazon Web Services (AWS)	Keras (Google; Francois Chollet)
LINE Clova	Theano (Montreal University)
IDCF Cloud (idc: yahoo)	MXNet (Amazon)
NIFTY Cloud	Cognitive Toolkit (Microsoft)
NTT Communications Cloud	Torch / Pytorch
Sakura Cloud	PaddlePaddle(Baidu)
Apple CoreML	DL4J (Skymind)
Oracle Adaptive Intelligence	Scikit-learn (David Cournapeau), PyML(Asa Ben-Hur),PyBrain
NVIDIA GPU Cloud	
Sony Neural Network Libraries	
Fujitsu Zinrai	

have been reports on physicians developing diagnostic imaging applications and medical devices that utilize AI as a new business. This is all thanks to the "democratization of AI." Even in the medical industry, it is expected that large companies will make practical use of profitable medical AI devices; however, in the field of medicine, there are various issues over a wide range of areas, some of which are problems that could likely be solved by radiologists and physicians using AI.

Medical AI in Japan

Although the number of radiologists per population is extremely low in Japan, the number of CT and MRI devices per radiologist is the highest in the world [25], suggesting that Japan requires the utilization of AI the most.

The level of enthusiasm for AI shown during the 2017 Radiological Society of North America conference was shocking. One could not enter the venue unless they arrived at least 30 min prior to the start of a lecture if the session had "AI" in the title. In contrast, the level of enthusiasm for AI in Japan is not particularly high, with opinions such as "I am too busy with my daily tasks to learn AI. That is something for the future. Even if I learned AI, it would not be useful ...".

Professor Yutaka Matsuo of the University of Tokyo has warned that Japan is an underdeveloped country when it comes to AI, and "it is unlikely that we can win in the international platform; in fact, we have almost lost." In recent years, young Japanese radiologists are losing interest in modalities such as CT and MRI due to the increasing number of daily tasks in their practice. If they are similarly unable to develop interest in AI, there may not be any need

for such radiologists in the future. Radiologists work day after day with the latest technologies, such as modalities like CT and MRI, and are most familiar with the latest technologies, such as AI.

Challenges with AI in medicine in Japan

In utilizing AI in medicine, in addition to the above-mentioned responsibilities, there are the following challenges.

1. Insufficient usable medical data.

Over several years, since it was said that “data are the crude oil of the twenty-first century (Martin Jetter/World Summit 2014 ICT), data (crude oil) have been changing into a valuable resource (oil) due to advancements in various technologies. Unfortunately, particularly in the medical field in Japan, medical data remain as crude oil due to the protection of personal information. There is a business opportunity in “refining” medical data into usable oil as soon as possible, so that researchers and companies can utilize the same.

Presently, the government is promoting a national database for AI utilization, but it will take time. The NIH prepared simple chest images from over 100,000 cases and CT scan data from 10,600 cases as an open database. In Japan, it is urgent that a similar database be created with instructors.

2. The process of making a conclusion is unclear in deep learning (DL).

To solve the unique nature of medical AI, wherein the diagnostic process must be explained, the development of a mechanical learning method that is most suited to medicine is necessary. In recent years, a hybrid-type algorithm was developed, wherein other machine-learning methods were added to DL, and there are new applications that are able to determine these processes. Furthermore, technology is being developed to solve the “black box problem” of AI.

3. Insufficient number of IT technicians.

In Japan, the lack of IT technicians is a serious problem, and the number will start to decrease further starting in 2020. Thus, it is necessary to promptly establish an AI education program in the medical industry.

4. Technology updates are extremely fast.

It is difficult to determine at what technological stage AI will become usable in a clinical setting, and continued learning after the purchase could lower precision. This makes AI management difficult.

5. Insufficient social understanding.

It will be extremely difficult to use AI if it cannot be used in medical sites until a perfect support system is developed. Good systems cannot be built without actu-

ally using them on site. Control of personal information is extremely strict.

6. The cloud is difficult to use due to protection of personal information.

It is impossible for just one company to create a next-generation environment for AI use; thus, a multi-vendor system is essential. Many international companies are developing applications that only operate on the cloud. Furthermore, individual hospitals are able to use high-performance and expensive super computers. For these reasons, the cloud is essential in AI use.

7. There is no standard model.

A national-level database is necessary. At the present time, the J-MID (Japan Medical Image Database) Project, which is an AMED (Japan Agency for Medical Research and Development) project, is in progress.

To realize next-generation medical care utilizing AI, radiologists have to solve the above-mentioned problems. We believe Japanese radiologists can solve them.

Radiologists in the era of AI

At the Radiological Society of North America conference last year, Prof. Curits Langlotz answered the question “Will AI ever replace radiologists?” by stating the following: “I say the answer is no—but radiologists who use AI will replace radiologists who don’t.” He further stated that “Radiology was a high-tech field from its beginning, and we have always been a high-tech specialty. We have partnered with technology innovators and learned clinically how to adopt new technologies.” “We’re going to learn how to deploy it clinically, when it’s worth using and when it shouldn’t be used.”

Let us now consider what the experts of diagnostic imaging must do to “provide service to each department through diagnostic imaging”: (1) provide accurate diagnostic imaging to all departments; (2) provide diagnostic imaging that uses the latest technology to all departments; and (3) build an appropriate image information system (PACS/RIS) and provide image information promptly and accurately to all departments. In the future, in addition to the above-mentioned services, establishing how AI is used in a clinical setting will be the responsibility of radiologists.

As photon-counting CT progresses, the modality itself will continue to evolve and new diagnostic imaging methods will appear. Only radiologists are capable of thinking of the appropriate clinical use, associated with AI. More than ever, the acquisition of knowledge (education) on the latest modality will be important for radiologists.

It is also important to develop AI devices and put them into practical use. For that purpose, co-creation by university

Fig. 3 Ideal platform for medical AI utilization

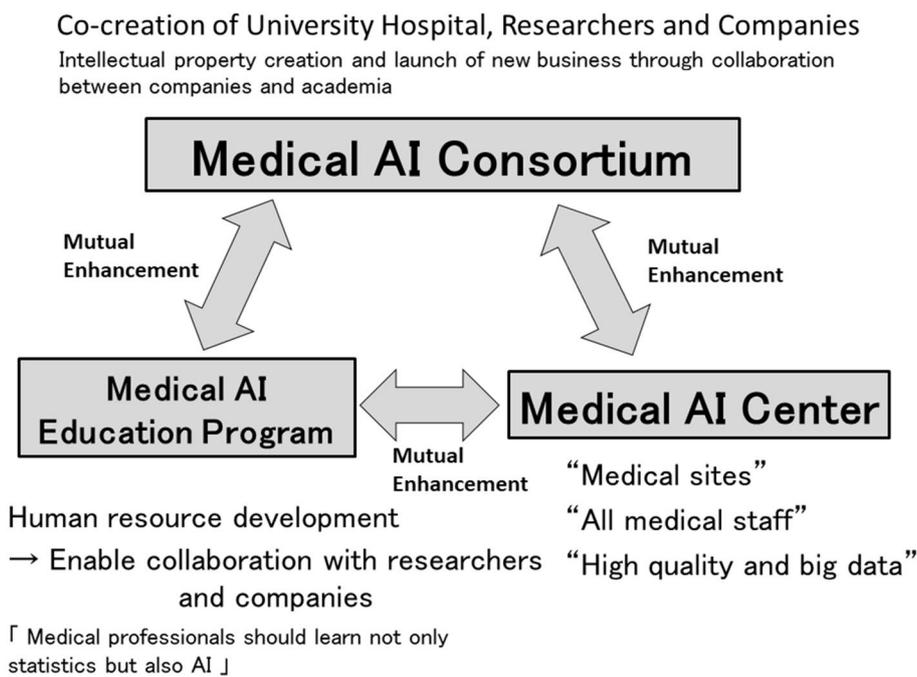


Table 3 Medical AI Education Program

Introduction
AI
Latest ICT such as IoT, Robotics, VR/AR/MR, Block Chain, 5G, Cloud, etc.
Knowledge on AI/ICT:
Basic knowledge
AI Environment improvement and programming (practical training)
e-Learning
Latest information
Medical policy and medical economics
Legal protection and intellectual property application
MOT(management of technology)
Business strategy and lecture on entrepreneurship (workshop)
Funding: Cloud funding, etc.
Understand the special problems of AI in medicine
Solving real tasks in medical field (workshop) by collaboration
Education and Approach to Middle Management Level

hospitals, enterprises, and AI researchers is important in the future, and it is necessary for the radiologists to lead the way to establish creative cooperative relationships (Fig. 3).

Considering the future of radiologists, we can visualize a data scientist who utilizes AI for analysis of not only imaging information but also clinical information and data to make a diagnosis. However, in this era where various technologies progress exponentially, it is almost impossible to predict a specific future. It is the responsibility of young radiologists to create next-generation medical care, where radiologists and AI coexist 10 or more years from now, as it is an era, where “all radiologists must learn AI just, as they learn statistics.”.

Who are the new generation of radiologists suited to this era of AI? First, they must have a broad perspective on overall medical care. Next, they must acquire basic information with regard to AI as well as the latest knowledge on modalities such as CT, MRI, and image information systems. Finally, as Dr. Obermeyer [26] said, “As in other industries, this challenge will create winners and losers in medicine. But we are optimistic that patients will emerge as the biggest winners as machine-learning transforms clinical medicine.” It will become increasingly more important for us as radiologists to not forget patient-centered medical care. It is an urgent matter to promptly actualize a medical AI education program that educates such radiologists and nurtures human resources (Table 3).

Conclusions

My response to the question “Is AI an enemy or ally of radiologists?” is “It could be either.” “If radiologists remain as they are, AI could become an enemy. However, if radiologists evolve to a new generation of radiologists suited to the era of AI, AI could become an unprecedented ally and dramatically progress medical care.” With the “democratization of AI,” it has now become an era where “all radiologists must learn AI just as they learned statistics.”

Compliance with ethical standards

Conflict of interest YK has received a research grant from Canon Medical Systems. MI and HK has no conflict of interest.

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