



## Artificial Intelligence in Medicine

Interview with Prof. Dr. Daniel Rückert, Alexander von Humboldt Professor for Artificial Intelligence at the Technical University of Munich

How can physicians and, especially, patients take advantage of the enormous potential of artificial intelligence? Prof. Daniel Rückert, Technical University of Munich, explains this, and how we can improve data protection and give patients more control over their own data.

**Bio<sup>M</sup>: Many people probably already know this: after an injury or during an organ examination, magnetic resonance tomography (MRT) and magnetic resonance imaging (MRI) are particularly precise imaging methods for making a diagnosis. You yourself combine computer science with medicine in your research. What exactly does your research involve and what is your vision?**

Professor Daniel Rückert: Our research involves the use of artificial intelligence, or AI for short, to extract as much information as possible from medical images. We can then make these available to the radiologist in order to make the best possible diagnoses and predictions about the progression of diseases in patients. Our goal is that artificial intelligence becomes one of the most important tools for radiologists to generate as much information as possible from medical data.

**The Alexander von Humboldt Foundation wants to attract top scientists to Germany by offering substantial research funding. In addition to the financial resources, what attracted you to accept this professorship at the Technical University in Munich?**

One of the aspects I found most attractive at the TU in Munich is the opportunity to work in an interdisciplinary manner. An important topic that we deal with is bringing computer scientists together with physicians and jointly researching problems and solutions to these problems. That's only possible if you bring experts from different disciplines together. The Technical University of Munich is one of the leading universities in Germany that has recognized that such collaboration is absolutely critical and has therefore made it possible for me, for example, to be located in both computer science and medicine at Klinikum Rechts der Isar. I found that to be a very attractive opportunity, and I am now looking forward to working with colleagues from IT and medicine here in Munich.

**In order to develop an AI, one needs data, often a lot of data. What are the particular challenges in the medical field?**

One of the major challenges in medicine or radiology is that we need data that is annotated by experts. This means that we need not only the original image data for radiological data, for example, but also the associated diagnoses. Of course, this can only be created by



experts. That is why it is very time-consuming to collect extremely large amounts of data for which you not only have the image data, but also the diagnoses.

**In the case of rare diseases, in particular, there is naturally little patient data. How can it still be possible to develop good AI with little data and thereby enable the most personalized treatment possible?**

There are two different strategies for doing this, and I'll try to outline both of them briefly. The first strategy is that you can bring together data from different hospitals, for example, and thus build larger data sets. Of course, even at a large university hospital like the Klinikum Rechts der Isar, only a certain number of patients come to the hospital for certain diseases per year. But if we look across Germany at how many patients there are with these diseases, we can bring these data sets together and thereby create larger training data sets for artificial intelligence. That is one strategy: by merging more data, I can train the AI better. The other alternative is to enrich the artificial intelligence by not only using data from patients with a certain disease, but also using data from patients with similar diseases and then training the AI to differentiate between these two different diseases, but can still obtain information from both data sets.

**So you are advocating for more data for medical research overall?**

More data for medical research is an important component for better artificial intelligence. But at the same time, of course, we have to be aware that data protection is a very, very important aspect, especially in the medical field, which we of course also have to take into account. Therefore, it's perhaps different in medicine than in other areas in which artificial intelligence is used very successfully nowadays, where it is much easier to collect data and worry less about data. This is different in medicine and something that we really also see as a challenge.

**Artificial intelligence has enormous application potential in many areas, but there is also uncertainty or skepticism regarding data protection. How can adequate protection, especially of sensitive health data, be guaranteed? Which ethical aspects play a role here?**

The ethical side is an important aspect. Ultimately, the patient must remain in control of their data. We need to always keep that in mind as the basis for many of the projects we do. But there are also technical advances in the field of artificial intelligence that allow us to train models with which we can build our artificial intelligence without having to compile all of the data. Instead of collecting data, we can send the models to the data. In this way, the models are improved on-site, i.e. in the hospital where the data is stored. We can then merge the models and integrate them into one large model. These techniques are often referred to as "federated learning". This distributed machine learning and what you can do



with it is a technology with which we could perhaps take better account of data protection and therefore allow the patient more control over the data.

**In an international comparison, how do you see the situation with regard to the availability of data, especially in Germany with its relatively strict data protection guidelines?**

Germany is a leader in many respects. Data protection is very important, and it is really in everyone's consciousness that data protection is a fundamental right that must be respected. At the same time, however, you have to see that Germany is in a way very conservative and careful with data, perhaps also based on past experiences in recent history. Compared to other countries, there is a gap that should be narrowed if you bear in mind the problems that can really be solved with the data. Especially in times of the coronavirus pandemic, there are of course really important aspects of how data can be used for the common good. You have to weigh the two against each other, the rights of the individual to his data and the right of the general public to use the data sensibly.

**What are your specific demands on politics in this case? What do we need to create more trust among the population?**

My greatest demand or request to politicians would be to address the issue actively. We can only make progress in this area if we consider people and society as a whole. Therefore, I would ask politicians to address this more and to allow more discussions about it – also with regard to what we can do with the data and how great the improvement of the general welfare can potentially be through the intelligent use of data. If politicians can work out this potential better and can also promote it, I think it would help us all a lot.

**And probably also create a little more sensibility in the general public?**

Absolutely. I think it is very important that the public get an understanding of what can and cannot be done with the data. A little more trust in the research is important so that the data is used for the benefit of the general public.

**This naturally also raises the question of oversight: whether and how AI can be controlled and even certified to ensure more trust and legal security for applications by the treating doctor. How do you think AI solutions can be tested?**

We have already reached a point where there are techniques that can be used to verify AI algorithms. But we also have to create more understanding that, in many areas of medicine, the AI will not function as an autonomous system, but will be an aid, a tool used by medical professionals to improve and facilitate certain work processes – and allow medical professionals to spend more time with the patient. So maybe you shouldn't focus too much on viewing AI as an autonomous system that has to be verified and is one hundred percent



secure. We're working in an area in which, in the near future and perhaps also in the distant future, the end result is that the medical professional will always cooperate with the AI. In English, this is referred to as the "human-in-the-loop system." This means that a person has control over the system and therefore of course ultimately bears the responsibility.

**Ultimately, the application of AI should reach the physicians in order to facilitate and improve diagnoses and thus also treatments. What will it take so that artificial intelligence can actually be used optimally in medical practices and hospitals, especially in diagnostics?**

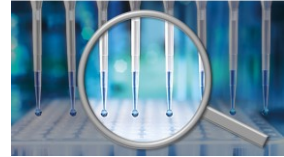
One of the absolute basic requirements for this is a fundamental digitization of all processes that take place in the hospital. I have been at the Klinikum Rechts der Isar for a few months now, and yet I am often surprised at how much is still communicated in paper form or in other non-digital forms, including faxes. Of course, this is one reason why translating artificial intelligence into clinical practice can also be more difficult. It is really absolutely critical that all processes are digitized as much as possible. There's another point I would like to make: it is also very, very important that the information or the data that one wants to use to bring about improvements through AI is collected in a structured manner. That means you have to define very clearly which data you need, which data should flow into the artificial intelligence. The process of data collection must be standardized and run uniformly in medical practices. This standardization has many advantages, i.e. it also makes it possible to monitor the quality of medical care and perhaps also to measure it in the long term – and this can have many positive aspects not only for the physicians but also for the patients.

**So not only do our teachers have to go to digital school, but also the doctors and medical professionals. You make it very clear: the fax machine has to go.**

Fax machines must go. But it struck me that there is a great will on the part of the medical staff and doctors to implement this digitization. In the end, for many doctors and nurses, digitization makes the process and their daily work much easier. That is why we have to make a joint effort to drive the process of digitization forward.

**Where do you think we will be in terms of the application of artificial intelligence in medicine, in imaging but also in other areas, in five years? And also, looking further ahead, in ten years?**

I hope that, in medical imaging, in radiology, we will get closer to the process that we already have in other areas, i.e. when you go to your physician now and have blood drawn. The physician sends the blood to a laboratory, where the blood is analyzed by a laboratory device, and a set of parameters or blood values is obtained that the physician can then interpret. I hope that it will also be the case in radiology that, for example, the images can be acquired, automatically analyzed, and parameters can be extracted through artificial intelligence, through intelligent algorithms. The radiologist can concentrate on the



interpretation of this data and no longer sits day in and day out in dark rooms in front of light boxes or at the computer screen to annotate images by hand and measure parameters. My vision for the future is – I don't know whether we will achieve this in five years or maybe in ten years – that this process will be much more automated. And I hope that this will then enable the physician to spend a lot more time with the patient.