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How to Integrate AI into Radiology Workflow

Summary: Where do the computer sciences have the potential to reduce radiologist burnout, reduce costs and make workflow more efficient and what are the first steps in implementing the technology?

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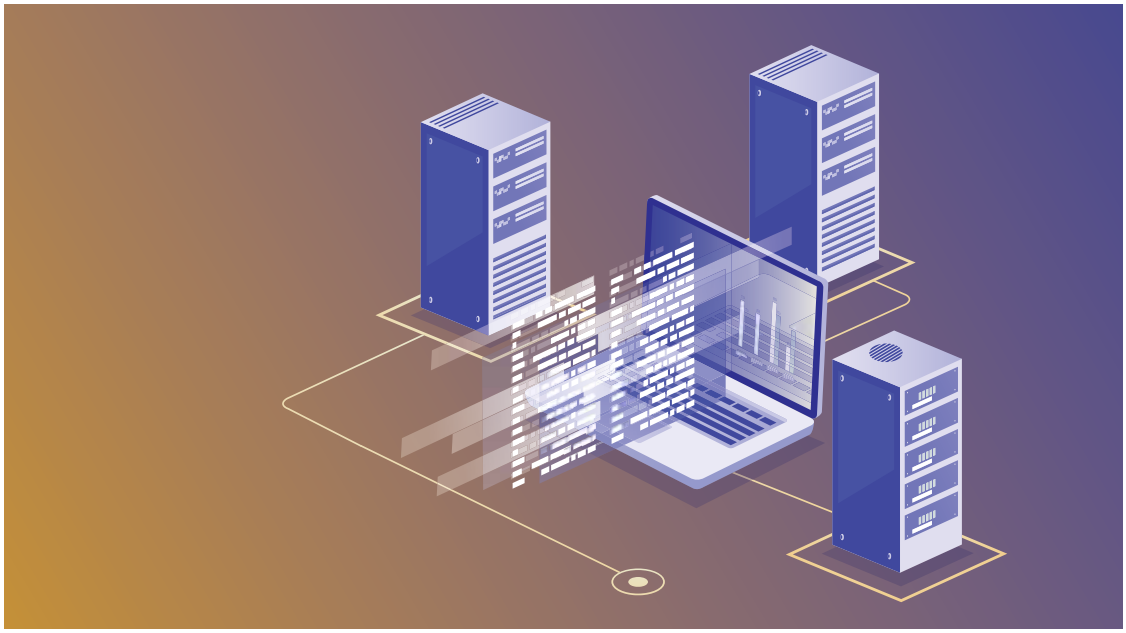

In the long-term future, I think that computers will take over the work of image interpretation from humans, just as computers or machines have taken over so many tasks in our lives. The question is, how quickly will this happen?

Another question is, what is Artificial Intelligence (AI)? How does it work? Is it terribly complicated and difficult to understand? First we had artificial intelligence, then machine learning (ML), a subset of AI, became popular in the 1980s. Since 2010 deep learning (DL) in turn, a subset of machine learning, has become widespread. Classical AI is what we used until the 1980s. It's what ruled most systems where humans tried to programme knowledge into the computer in order to let the machine react intelligently. It didn't work very effectively though, so, in the 1980's ML was more favoured. Here, machines actually began to learn from data, but the data was not images but rather numbers extracted from images. DL is unique in the sense that the computer learns everything directly from the images, so the involvement of humans in the process is much lower.

The question is, how can these computer applications be leveraged to improve different stages of the radiology workflow?

Integrating AI, ML and DL into Imaging

How can you incorporate AI, ML and DL into radiology? It's not just the algorithms; it's also the way they're integrated into processes.

Of course the traditional way of doing this is, AI place markers on suspicious lesions that merit a second look. This addresses the potential problem of an oversight in the case where a radiologist is tired and they miss something.

This system can give a large number of false-positives, but it can also be reassuring because, as a radiologist, you recognise there are always false-positives. This approach has the advantage that it can actually be useful even if the algorithm is not very good.

You can go further if you are distracted by all of these false-positives; some vendors don't show all the markers but they only appear when you click on the lesion. This is even easier to integrate into the workflow as you get a second opinion on a particular lesion and you get a score that you can take into account. However, the responsibility is still with you, the radiologist.

Scoring Whole Exams

There are also AI algorithms that can provide a score for an entire exam. A low-risk way is using this for triaging. The

algorithm can sort your work list and prioritise the cases where AI thinks there is an abnormality that may be urgent.

Perhaps this is not so adaptable for screening but some radiology units are using this for reading chest X-rays. A large number of radiology departments are overburdened as they have multiple chest X-rays to examine. If they read the most urgent ones first, then they can quickly contact the referring physician and get the patient treated.

Background AI Raising Alerts

There is the possibility of having AI running in the background and, if the radiologist reads the case as normal and the AI is more suspicious, it raises a flag and asks for another radiologist to look at that case. An advantage is it's unobtrusive. It might present some risk for overall diagnosis, but it is easy to integrate into the workflow.

You could also do it the other way round; if the radiologist thought a case needed special attention, you could let the AI look at it and maybe it, in some cases, would disagree with the need for a referral. This could be one way of reducing unnecessary work.

Reducing Double Reads and Costs

There's also the option of going one step further and actually letting the AI score every exam rather than send each one back to radiologists for a double reading. If the computer thinks the chance of cancer is very low, then you only do a single reading. This would lead directly to cost-savings.

A radiologist team could build on this, only do a single reading by humans, and let the AI produce a score, acting as a second reader. If there was non-consensus on the outcome, a radiologist would act as arbitrator between the opinions on the readings.

By the same token, there's the possibility of letting AI arbitrate to make the final decision. It would also be interesting then, if AI had access to the lesion that was marked by the human reader and could make the final decision, as the question would really be: 'Who would make the better arbitrator? The computer or the radiologist?'

Of course, now we are getting into more dangerous waters because AI would decide what to look at more closely so the computer could be the reason why something critical was missed. You could advance further with this paradigm and simply have a subset of exams that nobody looked at and the AI would select a number of exams that needed to be examined by human readers. Here of course the performance of AI has to be very efficient, but there's also another thing that is actually very important; that AI should not make a really terrible error, because this would probably not be accepted by society.

Selective Examination with AI

Another point that is very important in some settings (but probably not for plain mammography) is, if the exam was very large and going over the entire case was very time-consuming, that the computer could home in on areas that the radiologist needed to examine.

This is something we are already doing in automating lung screening with CT. Going through an entire CT scan is extremely time consuming. If we implemented lung cancer screening in Europe, we would not have enough radiologists to scroll down all the CT scans, so maybe you only need to look at the cases and the slices of potential nodules selected by the AI. This could also show a lot of potential for 3D ultrasound.

AI Autonomy and Ethics in Radiology

Finally, maybe autonomous AI will be the end goal. This scenario would offer the greatest cost-savings because there would be no need for humans anymore. However, in this case, there could be the issue of disastrous errors made by AI.

I think, in the end, it's more of a legal matter than a technical matter whether society wants to employ these kinds of algorithms. In fact, such systems already exist for diabetic eye screening that have been approved by the Food and Drug Administration. No doctor needs to look at the image; the AI decides who should go to see an ophthalmologist.

How Should We Use AI in Our Workflow?

In reality, there are many possibilities so, in the near future, what can we expect from AI and radiology?

I think within the next five years, AI will be introduced quite gently, in ways that will create minimal risks to workflow speed. This is important as, otherwise, the radiologist would not accept it for triage or background operations. I think radiologists would actually welcome AI if they used it and saw that it took over the repetitive aspects of their work and functioned successfully.

If you were to calculate how many tasks radiologists are doing, you would get a very long list. For many imaging areas, there are no AI systems yet.

But in the long term I am very positive because I think that AI will massively improve the health gap, especially where there is a lack of high quality healthcare. In a Western setting, I think AI will reduce costs significantly. At the end of the day, it is very important to keep healthcare affordable. ■

This article is based on a lecture Prof. Ginneken presented at EUSOBI 2019 in Budapest.

KEY POINTS

- AI could target different radiology modalities and workflows to make processes more efficient, reduce staff burnout and cut costs.
- The technology could be deployed in multiple ways such as in background monitoring or double reads.
- Society would not accept AI making serious errors.
- Many areas of radiology don't yet use any AI systems.
- Gentle introduction over next five years and visible success will make AI integration into radiology smoother.