Title: How AI is Changing Medical Imaging: The Invisible Assistant in the Scan

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Abstract

For many years, the job of reading X-rays, MRIs and biopsy slides has depended on the expert knowledge and experience of the health care professional that interprets these images. This has been a slow and tedious process. A new and powerful technology has now joined health care professionals as their reading partner - not to replace the specialist, but to assist in interpreting medical images. The introduction of artificial intelligence through machine learning and deep learning is changing medical imaging by enabling radiologists to interpret large amounts of medical data and convert them into useful information more quickly and accurately than has ever been possible before.

1 How It Works: Teaching Computers to See

The teaching of computers how to interpret images is based on how well a computer can recognize patterns in pictures. To be able to teach a computer how to recognize patterns of images, we need to provide the computer with a large amount of data containing labelled images. For example; for a mass screening programme for breast cancer, thousands of mammograms that have been labelled as being “normal” or “suspicious” are used to train the computer on the patterns associated with a breast cancer tumour. A more advanced type of computer learning, deep learning uses an artificial neural network to classify images into categories based on a series of layers, where each layer builds on the previous layer until the network can learn what a tumour looks like by seeing lots of examples of what a tumour looks like, instead of training the network to recognize a tumour by presenting a detailed description of what a tumour would look like. As a result, deep learning computers have been shown to be able to identify many subtle patterns (e.g., microcalcifications) that may not be apparent to the human eye[1,2,3,4].

2 The Effect on Real Life: From Recognizing to Telling You What's Likely to Happen

It's not simply an idea. AI has already arrived at hospitals and clinics, and it is having an immediate effect [10].

2.1 An Unflagging Partner: The radiologist typically examines many hundreds of images a day. Because radiologists are human, they have limits on how tired they can become. AI is the constant backup to catch errors that are emotional in nature (for example, a brain bleed or collapsed lung). AI is able to identify very early signs of lung cancer, as well as the smallest fracture that may be overlooked.

2.2 Providing Information Beyond Yes and No:AI has the advantage of measuring what it detects, not simply detecting it. When presented with an MRI of a tumour, AI can automatically create a 3D model of the extent of the tumour and compute an accurate volume. This allows the treating physician to monitor the effects of treatment objectively and directly. In another area, AI can quantify the changes that take place in the brain that are caused by Alzheimer’s disease or other neurodegenerative diseases.

2.3 Understanding What’s Next: The most exciting applications of AI involve predicting what is next from a patient’s perspective. By examining the imaging characteristics taken in conjunction

with clinical data, machine learning can identify what a patient's risk (or outcome) may be. For example, how aggressive is this glioblastoma going to be? (The likely expected outcome from using machine learning here is the patient will have a worse prognosis than a patient with a less aggressive glioblastoma.) Or, what is the patient's likelihood of having a heart attack, based on coronary artery calcium score?

3 Getting a New Workflow Up and Running: Behind the scenes of using AI + Radiology is that it increases efficiency throughout the entire system. For example, an AI system can identify the highest priority case(s) within the queue of radiologists (the order in which images are to be reviewed or interpreted) so that the Radiologist interprets the most critical images first. It can also improve the quality of images created from Magnetic Resonance Imaging (MRI) and/or Computed Tomography (CT) scans and can significantly decrease the time an MRI takes to produce a diagnosis or reduce the radiation exposure to patients from CT scans without compromising diagnostic quality.

4 Overcoming the Barriers of Trust, Bias, and Integration

While AI has the potential to revolutionize how Radiologists interpret images, it is also necessary to exercise due diligence when using such advanced technology.

4.1 The Black Box Problem of AI: If an AI recommends a particular course of action, it is necessary for a physician to understand how the AI made that recommendation. Explainable AI (XAI) seeks to enhance the transparency of the decision-making process of AI systems so that radiologists can build trust with the technology as true clinical partners [6].

4.2 Surveillance of Biases: An AI can only be as effective as the quality of the data used to develop the algorithm. If the training data for the algorithm is not diverse, the algorithm will not perform well. Therefore, it is essential to ensure that an algorithm is trained using large collections of global datasets that are representative of the entire world to ensure healthcare equity [8].

4.3 Integrating into Human Workflow: AI that is cumbersome can be of no use. AI systems must be efficient enough for very busy physicians to use without increasing their burden of number of mouse clicks or windows; AI should seamlessly fit into the existing system as much as possible and provide relevant and timely information exactly where and when the physician needs it [9].

5 The future

The future does not aim to create radiologists that perform automated work but to enhance the capabilities of current radiologists. In the future, instead of performing all of the initial screen testing and quantitative measure, the use of AI would provide those functions and free radiologists to provide the more complex and difficult-to-diagnose cases and also allow them to have more time to consult with patients and produce more detailed treatment recommendations. The role of the clinician would not solely be acting as a "pattern finder" but as an interpreter of the findings and an integrator of the care provided by different healthcare professionals based on the data collected about the patient.We are also beginning to see the development of other new types of Medical Imaging technologies such as AI that are capable of creating synthetic medical images which will help during the training process, the development of AI algorithms that can integrate the results of scan and genetic data to create a more complete picture of the patient, and portable

ultrasound devices that are guided by AI to provide physicians with the ability to provide the same level of care remotely.

The field of medical imaging has undergone a rapid transformation, and AI and Human collaboration will create the greatest innovation for patient care in the future by utilizing the advantages of both AI and human intuition.

6 References

1 Ardila, D., Kiraly, A. P., Bharadwaj, S., Choi, B., Reicher, J. J., Peng, L., ... & Shetty, S. (2019). End-to-end lung cancer screening with three-dimensional deep learning on low-dose chest computed tomography. *Nature Medicine*, 954-961.

2 Bakas, S., Akbari, H., Sotiras, A., Bilello, M., Rozycki, M., Kirby, J. S., ... & Davatzikos, C. (2018). Advancing The Cancer Genome Atlas glioma MRI collections with expert segmentation labels and radiomic features. *Scientific Data*, 170117.

3 Erickson, B. J., Korfiatis, P., Akkus, Z., & Kline, T. L. (2017). Machine learning for medical imaging. *Radiographics*, 505-515.

4 Gulshan, V., Peng, L., Coram, M., Stumpe, M. C., Wu, D., Narayanaswamy, A., ... & Webster, D. R. (2016). Development and validation of a deep learning algorithm for detection of diabetic retinopathy in retinal fundus photographs. *JAMA*, 316(22), 2402-2410.

5 Higaki, T., Nakamura, Y., Zhou, J., Yu, Z., Nemoto, T., & Awai, K. (2020). Deep learning reconstruction at CT: phantom study of the image characteristics. *Academic Radiology*, 82-87.

6 Holzinger, A., Biemann, C., Pattichis, C. S., & Kell, D. B. (2017). What do we need to build explainable AI systems for the medical domain?. *arXiv:1712.09923*.

7 LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep learning. *Nature*, 521(7553), 436-444.

8 Obermeyer, Z., Powers, B., Vogeli, C., & Mullainathan, S. (2019). Dissecting racial bias in an algorithm used to manage the health of populations. *Science*, 366(6464), 447-453.

9 Topol, E. J. (2019). High-performance medicine: the convergence of human and artificial intelligence. *Nature Medicine*, 25(1), 44-56.

10 U.S. Food and Drug Administration (FDA). (2023). *Artificial Intelligence and Machine Learning (AI/ML)-Enabled Medical Devices*. Retrieved from https://www.fda.gov/medical-devices/software-medical-device-samd/artificial-intelligence-and-machine-learning-aiml-enabled-medical-devices