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AI, are dermatologists' days numbered?

Modern medicine is not perfect and can always be improved. It is hardly a surprise that investing in healthcare related artificial intelligence (AI) projects was more popular than any other sector of the global economy in 2016. (1) The sci-fi genre has often portrayed AI as threat to mankind and as a result, many believe that advancements in medical AI could have a domino effect on the employability of human doctors. This portrayal was reinforced when multiple researchers tested the diagnostic capabilities of convolutional neural networks (CNNs) against board-certified dermatologists with varying levels of experience. Identifying a benign mole or a malignant melanoma and then making a management decision (discharge, follow-up, admission/surgery) is something dermatologists do on a daily basis; but in this study they were up against a CNN and only had access to an image of the lesion. The doctors were given clinical information (sex, age, location of lesion) 4 weeks later and made their decisions again. In both scenarios, the CNN performed better. "The CNN missed fewer melanomas, meaning it had a higher sensitivity than the dermatologists, and it misdiagnosed fewer benign moles as malignant melanoma, which means it had a higher specificity; this would result in less unnecessary surgery," said Professor Haenssle.(2) The media enjoyed this; as articles with titles like ‘machine beats man’, ‘the rise of AI’ or titles to that effect were published rapidly. Accurate diagnosis is what the study relied on and hence medical diagnosing will be discussed first.

Diagnosing

‘Diagnosis’ comes from the Greek for ‘to discern/distinguish’; hearing more than what patients say. Often, the process is split into 4 steps for a student’s benefit:

1) Patient history: discern important facts

2) Differential diagnosis: conditions which explain the presentation ("when you hear hoofbeats think horses, not zebras")
3) Narrow differentials and order investigations
4) Confirm hypothesis and seal diagnosis

Move from symptom to cause; an idea which has been taught and imprinted in medical students' minds for centuries. In 1945, Gilbert Ryle gave a lecture about two different kinds of knowledge; "knowing that" (the propositional and factual kind) and "knowing how" (skill based, implicit, experiential). One depends on the other and both are broadened together. Do diagnosticians rely on one more than the other?

A study investigated the brain activity of radiologists while they were making diagnoses. (3). Lung x-rays with pathological lesions, outlines of the letters of the alphabet and line drawings of animals were shown in random order while an MRI scanner tracked their brain activity. They required, on average, 1.33 seconds to reach a diagnosis and a month shaped band above the posterior base of the skull and a wide delta of neurons near the left ear lit up consistently throughout the experiment. "Our results support the hypothesis that a process similar to naming things in everyday life occurs when a physician promptly recognizes a characteristic and previously known lesion," the researchers concluded(3). Extrapolating from that conclusion, to a dermatologist, identifying a mole could be similar to identifying an animal. Frameworks like the ABCDE approach to examining moles makes the process easier.

When someone sees a giraffe, they don't consider and eliminate other possibilities. Long necks and a pattern of spots make the animal a giraffe and the brain understands that instantly. 'If it looks like a duck, swims like a duck, and quacks like a duck, then it probably is a duck'. Making a diagnosis on an x-ray in 1.33 seconds is something which requires years of training and

experience. Doctors make mistakes, learn and grow and reach that level of competency. Can machines do that too?

AI and Medicine

Technology in medicine is not unheard of; patient records are digitised, appointments can be booked online and patients can check into clinics via a tablet or a phone. Additionally, (5):

1) Online therapy: AI therapy is an option for people who have social anxiety
2) Robot assisted surgery: Surgeries which were not possible with an entirely manual approach are completed using the da Vinci robotic surgical
3) Support systems: Programmes like DXplain can come up with differential diagnoses when symptoms are inputted

According to a study, doctors spend 27% of their day with patients and the rest goes into entering data or working on some other form of documentation (6). AMA immediate past president Steven Sack said "what many physicians are feeling—data entry and administrative tasks are cutting into the doctor-patient time that is central to medicine and a primary reason many of us became physicians."(5) The use of AI could allow doctors to invest their time into seeing more patients; making the healthcare system more efficient.

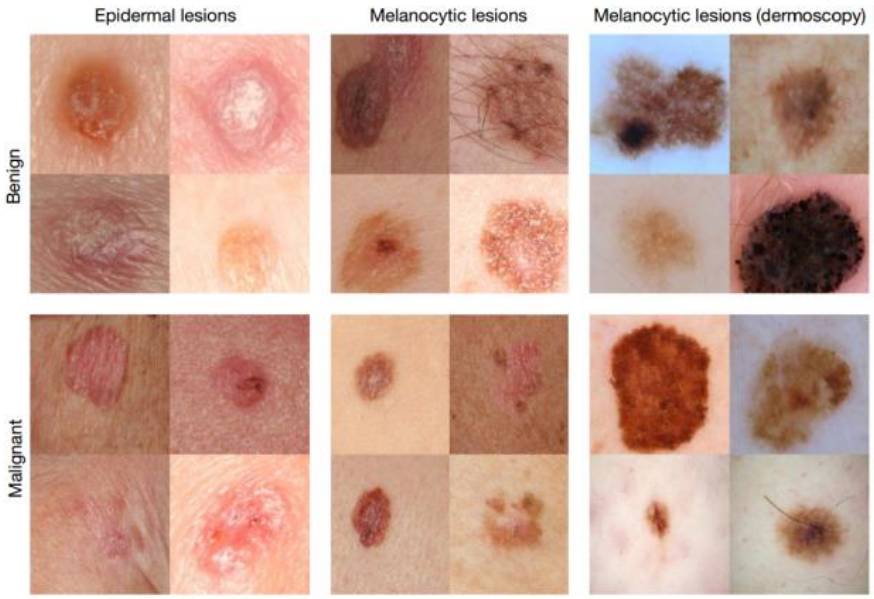
CNNs

Doctors do use machines to make diagnoses; an electrocardiogram for example can identify abnormal wave forms based on rules inputted during programming and can then flag certain conditions (e.g. ventricular tachycardia) for doctor review. Mammography scans usually flag suspicious areas for up for review by a radiologist. These machines, however, don't learn. An ECG machine used 5000 times is no wiser than one used just once.

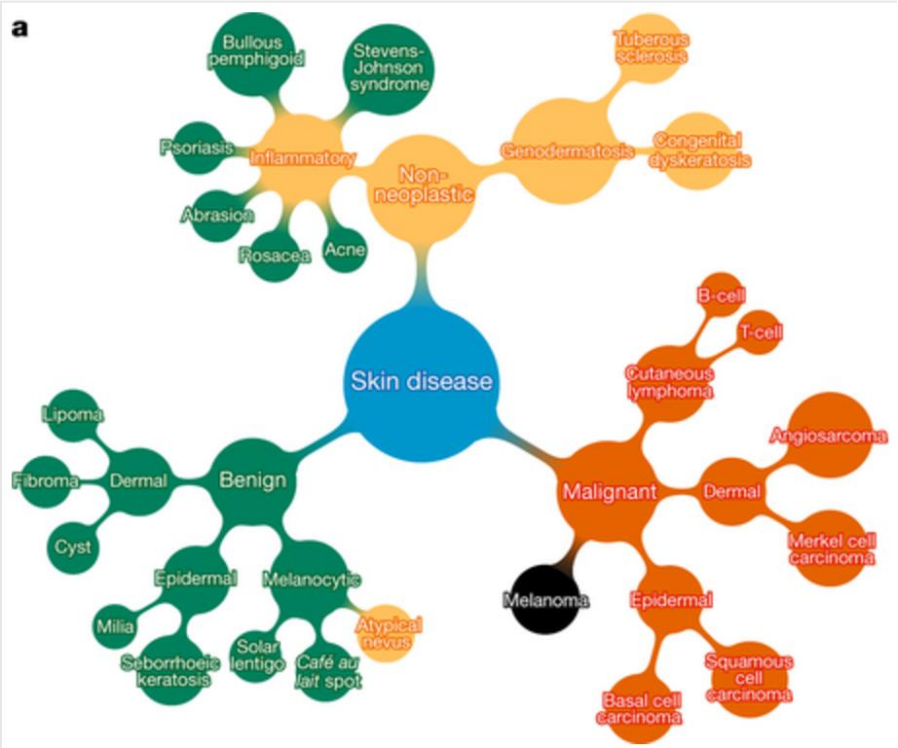
CNNs, however, are capable of teaching themselves and improving their own performance. They learn from images that are fed into its system; much like how the neurones in the brain respond to what the eyes see. A researcher's attempt to simplify this process was to describe the CNN as the brain of a child.

Children learn to identify things in bits and pieces. For example, when a child first sees a dog, he doesn't know what it is. Information is given to him and a child may start associating all furry 4-legged animals with a tail as dogs. That will be incorrect when he sees a wolf for example and the child will extract information from various scenarios and encounters to create his own way of recognizing a dog. CNNs grow and develop in a similar way.

CNNs and Dermatology



Even though the process of identifying a lesion could be similar to naming an animal, the process can certainly be quite hard as some lesions are difficult to tell apart. The image on the right shows a few examples(7). Neural network studies have been repeated several times and the research carried out by Stanford university will be talked about here. A pre-trained version of the Google Inception-v3 deep neural network was trained by inputting 129,450 skin lesion photographs from public databases and data obtained from hospitals. The photographs represented 2032 different diseases (taxonomy below(8)). "Red indicates malignant, green indicates benign, and orange indicates conditions that can be either. Black indicates melanoma."(8)



The aim was to differentiate between:

1) Keratinocyte carcinomas and benign seborrheic keratoses (most common scenario)
2) Malignant melanomas and benign nevi (deadliest scenario)

The CNN performance was on par with, and in some cases better than dermatologists in both scenarios; demonstrating competence. A deep learning system beat doctors at a task they are specifically trained to perform. Does this mean dermatologists will be out of a job very soon in the future? Not quite.

The entire paper mentioned using 9 subgroups of diseases; that leaves around 2023 diagnoses for the doctors. AI systems will not fully replace dermatologists because in dermatology (and indeed across medicine), most conditions are rare. Rates of 1 in a million are not uncommon and considering the system relies on image input, to learn and grow effectively hundreds of millions of cases will be required to teach the system all the diagnoses.

More importantly, AI systems do not have explanatory powers. They can solve a case but cannot build one. The most powerful element in a clinical encounter is knowing why. This is true for dermatology too. Was there a specific event which triggered a particular rash? Why is this mole where it is? To patients, clinical visits are more than just finding an answer to their problem. They seek comfort and reassurance, something which doctors are trained to provide and have empathy skills for. Until AI systems master empathy (at that point will they be any different to humans?), dermatologists and doctors are staying.

Conclusion

The industrial revolution did not replace farming; it improved efficiency. The telephone did not replace human voice; it made it louder. Therefore, I believe AI systems are going to augment dermatology, not take over it. There is a lot of work to be done before it happens but as mentioned at the beginning, medicine is not perfect. The future of dermatology could be patients taking pictures of moles before coming in to see a doctor who would have a diagnosis on hand. AI could flag serious cases up quicker. Dermatologists could specialize further into rare diseases. In conclusion, dermatology is heading into evolution thanks to artificial intelligence, not extinction.

Word count: 1448

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