Artificial Intelligence and Dermatologists: Friends or Foes?

Artificial intelligence (AI) and deep machine learning have the undoubted potential to revolutionize every aspect of modern living. AI is the overarching term encompassing intelligent machines whereas machine learning is the dynamic subset of AI that is able to modify itself. Deep machine learning is a further subset which is modeled loosely on complex and multilayered human neural networks allowing for an even more accurate recognition and interpretation of data, especially patterns [Figure 1].[1]

Globally, AI controls power grids and vital infrastructures, serves as a portable assistant on smartphones, and is already driving autonomous vehicles. AI is, therefore, no longer a realm of fantasy or the sole province of academics but is rather being heavily incorporated into human society. While many hail the unimaginable benefits of intelligent automata, others consider the rapid developments to be a looming threat to our very existence.[2]

Available Artificial Intelligence in Medicine

AI has proven valuable to the everyday practice of medicine, from simple automated blood pressure monitors to robot-assisted surgeries; AI tools in medicine are the new norm globally.[3] The recent tremendous growth in this field has also delivered many firsts with the first Food and Drug Administration (FDA)-approved, unguided AI tool (IDx-DR) for the diagnosis of diabetic retinopathy based on retina images in 2018. There are also FDA-approved mobile apps that help treat opioid addiction (2017) and aid with contraception (2018), further enhancing the digital–human partnership.[4]

Artificial Intelligence and Dermatology

In dermatology, the highly visual and tech-intensive nature of the field positions it at the forefront of advances made in AI. While there has been a number of mobile apps developed to detect moles or diagnose inflammatory skin lesions, their track record of accuracy is largely unproven and questionable.[3] AI platforms, however, have been used to analyze large datasets of skin lesions, and some successful deep learning algorithms have consistently approached and even outperformed expert dermatologists.[4] While it is hard to dismiss the notion that AI certainly has the potential to change the day-to-day practice in dermatology, it is unlikely it will make dermatologists redundant.

What Can Artificial Intelligence Currently Do?

Recently, a study in Germany tested machine learning in dermatology and demonstrated that "deep learning convolutional neural networks," or CNN, detected potentially malignant skin lesions better than 58 international dermatologists.[5] Moreover, in the field of histopathology, and of relevance to dermatopathology, whole-slide imaging followed by automated interpretation of tissue samples displayed a high degree of confidence in diagnosing and grading various other forms of cancer[6-8] [Figure 2].[1]

As the rates of skin cancers continue to climb, AI and machine learning algorithms could reverse this deadly trend by supplementing decision-making in dermatology and by verifying the work of dermatologists. Moreover, as the demand for dermatological services far exceeds the available supply, the provision of such services by underqualified personnel leads to potentially significant diagnostic errors.[9] With the necessary technologies, AI could, therefore, dramatically reduce error rates worldwide and increase the availability of services in less-developed and/or less-served areas via the application of virtual reality through teledermatology.[10]

Limitations of Artificial Intelligence

The promising potential of incorporating AI into routine dermatology practice is not without its challenges. AI requires extremely large datasets of images/slides for an accurate enough algorithm to be "learned."[11] This huge volume of data does exist globally – albeit in analog form with millions of slides held in storage around the world, and images of skin lesions stored electronically – but the utilization of such resource is complicated by many technical hurdles. Different centers may also stain slides differently, and the too many variables in imaging skin lesions (lighting, angles, device used, etc.) limit the generalizability of AI conclusions.[12,13] Moreover, a single high-resolution virtual slide/image can be too data – consuming that when accounting for costs needed, these hurdles may be too computationally intensive possibly to a degree that is impractical to implement in many centers around the world.[14]

While it is reasonable to suggest that technical solutions may be found in the near future to overcome the data problem, AI is also limited by many biases. If the datasets used to develop the algorithms have biases, they will be introduced into the algorithm results. An example could be that images with rulers may be more likely to be labeled cancerous because images in datasets with rulers are probably more likely to be malignant. Arguably more serious, however, is the issue of racial disparities seen in cognitive computing. Racial disparities in AI and machine learning are not a new issue. Algorithms have mistaken images of people with darker skin for gorillas, misunderstood Asians to be blinking when they were not, and "judged" only fair-skinned people to be attractive.[15]

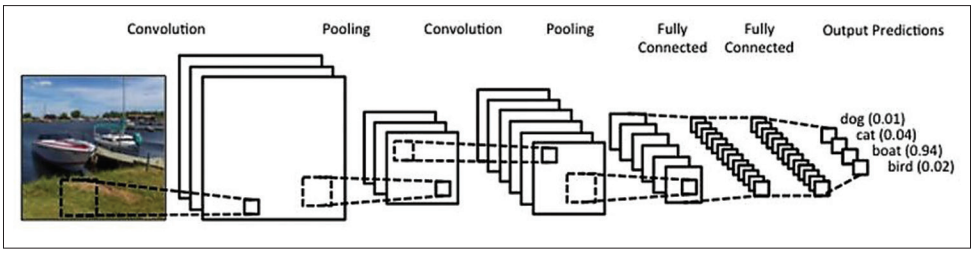

Figure 1: A multilayer neural network relates pixels to each other using algorithms to minimize the error

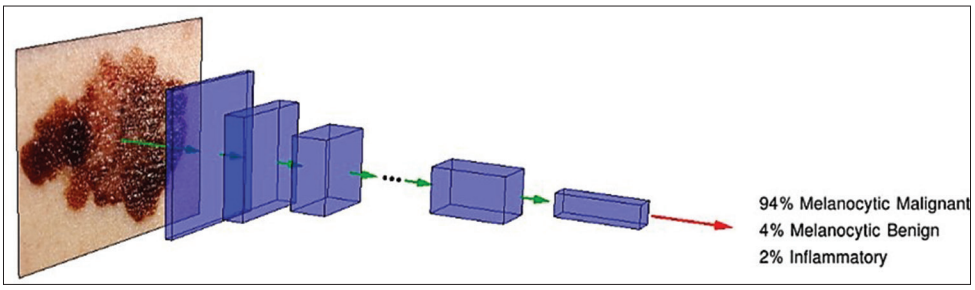

Figure 2: Artificial intelligence in action; convolutional neural network outputs a malignancy probability for each image

For years, the bulk of dermatology research, especially in the area of skin cancer, has been conducted on the fair-skinned populations of Europe, America, and Australia, leaving out marginalized communities whose symptoms may manifest differently.[16] This reflects directly in the datasets available that can be used to develop AI algorithms. Therefore, if AI has "learned" how skin lesions may manifest in a specific ethnic group, theoretically, it will likely underperform when it comes to diagnosing lesions in people of other ethnicities. With inadequate data, AI may misdiagnose people of color with nonexistent skin cancers or miss them entirely.[15] This exclusion may stem from the lack of medical professionals from marginalized communities, inadequate information about those communities, and socioeconomic barriers to participating in research.[17] This is also compounded by the higher rates of skin cancers observed in fair-skinned people.

Ultimately, this means that the higher mortality rates of skin cancers reported in people of color are likely to persist despite the potential advent of AI in dermatology.[18] Fundamental changes need to be implemented to ensure a representative and an adequate repertoire of imaged skin lesions. A more equitable demographic participation in clinical trials and improving ease of access to dermatology services globally are, therefore, paramount. This should eventually result in a more diverse dataset for AI algorithms to learn from and subsequently apply to the diverse populations it serves. The solution is not necessarily easy, but it is rather simple.

Artificial Intelligence and Dermatologists: Friends or Foes?

While it may sound unsettling to members of the profession, this technology may ultimately downsize the specialist dermatopathology workforce needed, or at least the amount of time dermatologists spend on clinical workload examining lesions, especially pigmented ones. Nevertheless, it seems highly unlikely that dermatologists or dermatopathologists will be faced with an existential crisis and be replaced by "virtual dermatologists" for many reasons. While AI may have a higher predictive accuracy using algorithms learned from extremely large datasets of very similar pathology, humans are far superior in recognizing mimetics and rarer, more unusual diseases where data available are inadequate or patterns too few to be learned[3] [Figure 3].[19]

In addition, aside from sophisticated AI, pigeons have also been shown to accurately distinguish between cancerous and noncancerous tissues, and as such, the ability to analyze the tissue samples may not be innately a human quality, but it does require the meticulous evaluation by human intelligence to be integrated with all other clues.[20] The role of dermatologists is not limited to examining standardized images or lesions in isolation. Perhaps, the most unique of all to dermatology, is the importance of tactile perception and the invaluable information that can be gathered through it. This is something too challenging for machines to learn how to perform; even more challenging is the integration of all macroscopic, microscopic, molecular, and critically valuable clinical variables to address patients' needs. Indeed, two rashes may look visually identical despite one being a viral exanthem while the other is a drug-induced allergic reaction. Dermatology is not linear; dermatologists think, touch, cut, and connect. This makes it difficult to convert clinical decision-making into a standardized algorithm for easy interpretation by machines.

Artificial Intelligence Potential in Dermatology

The availability of reliable AI technologies that can interpret skin lesions as well as human dermatologists will be of significant

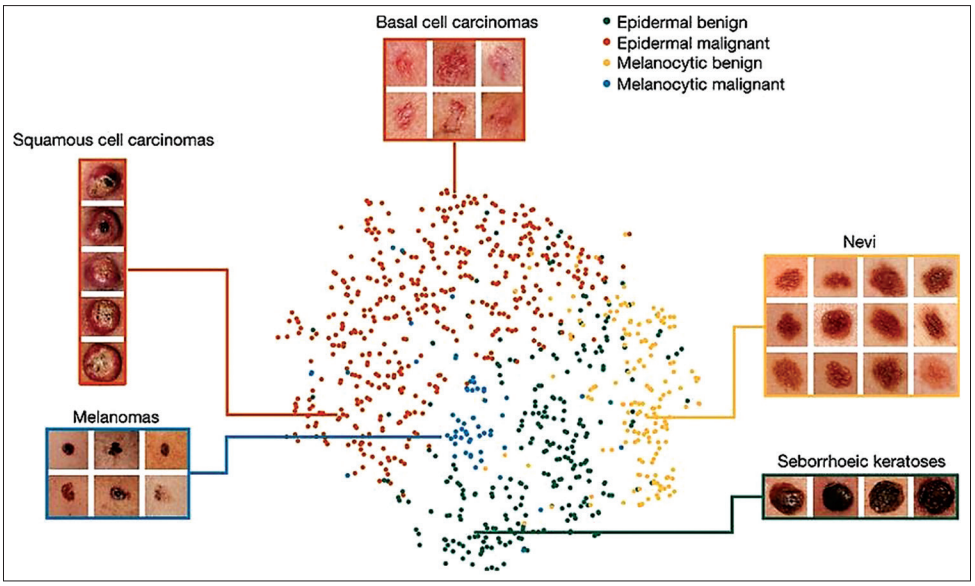

Figure 3: Schematic illustration of how artificial intelligence visualizes different biopsy-proven disease categories

benefit to research-active and academic dermatologists. In recent years, the amount of experimental data in biomedicine has expanded exponentially secondary to advances made in high-throughput, large-scale omics technologies. The progression of biomedical research nowadays is, in fact, more restricted by the ability of scientists to interpret and process data, not to generate it.[21] AI will, therefore, likely be of significant help in affording clinician-scientists in the field of dermatology and increasing amount of time to further basic, translational, and clinical research.

Conclusion

In the era of rapidly advancing AI and machine learning, dermatologists may soon find themselves obliged to employ these technologies if they are proved to improve patients' outcomes. Nevertheless, the suggestion that they should fear unemployment, as a result, is based on a flawed understanding of their role in the routine care of patients. While dermatologists may find themselves pitted against AI, the profession of dermatology needs to quickly adopt AI and embrace its potential in clinical, academic, and research settings. This will likely require changes to current working and educational practices to permit proper utilization of highly efficient AI tools. Dermatologists may also be more involved in research and training schemes in dermatology should they start reflecting that by training and encouraging trainees to undertake research with a particular focus on digital health informatics and data analyses.

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