AI, are dermatologists' days numbered?

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INTRODUCTION

Artificial Intelligence (AI) is the concept of machines performing intelligent behaviour such as perception, reasoning, learning and communication, with the aim of them ultimately achieving human intelligence[1]. It has been defined as a 'system's ability to correctly interpret external data, learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation'[2]. Although AI is still in the early stages of development in the healthcare sector, their potential is far reaching, particularly in disciplines where visual recognition is the mainstay of diagnosis such as dermatology. Neural networks are already able to use complex algorithms to identify patterns humans cannot[3]. AI could result in greater diagnostic capability and optimised patient care. However, they are difficult to train, there are ethical and legal concerns, and fundamentally humans prefer human contact which casts doubt on the complete replacement of dermatologists by AI.

SUCCESSES OF AND OPPORTUNITIES FOR AI

NEURAL NETWORKS AND SKIN CANCER DIAGNOSIS

Traditional computer programming processes inputs by hand crafted programmes to generate an output. Machine learning, in contrast considers inputs and outputs together to 'train' a computer generated programme, which can then take new

inputs and infer outputs, thus becoming autonomous. Neural networks take machine learning a step further by processing data sequentially through layers creating a robust predictive system[4] [figure 1]. Esteva et al. used a dataset of 125,450 photographic images to train a deep learning convolutional neural network (CNN) to discriminate between benign and malignant pigmented lesions and benign and malignant epidermal lesions[5]. When tested this network performed on par with 21 board certified dermatologists. Another study[6] compared a CNN's diagnostic performance of melanoma against 58 dermatologists including 30 experts and found that the majority of dermatologists were outperformed. Their recommendation was that irrespective of a physician's experience, they could benefit from CNN image

classification.

Early detection of skin cancer, particularly melanoma, reduces mortality and morbidity from extensive surgical removal and aggressive systemic therapy[7]. Early detection also reduces overall cost of care as early stage treatments such as simple excision are far cheaper than late stage procedures[8]. AI offers a great opportunity to allow accurate early diagnosis of lesions, possibly even in primary care thus ensuring appropriate referrals and reduced costs.

OTHER SUCCESSES IN PATTERN RECOGNITION

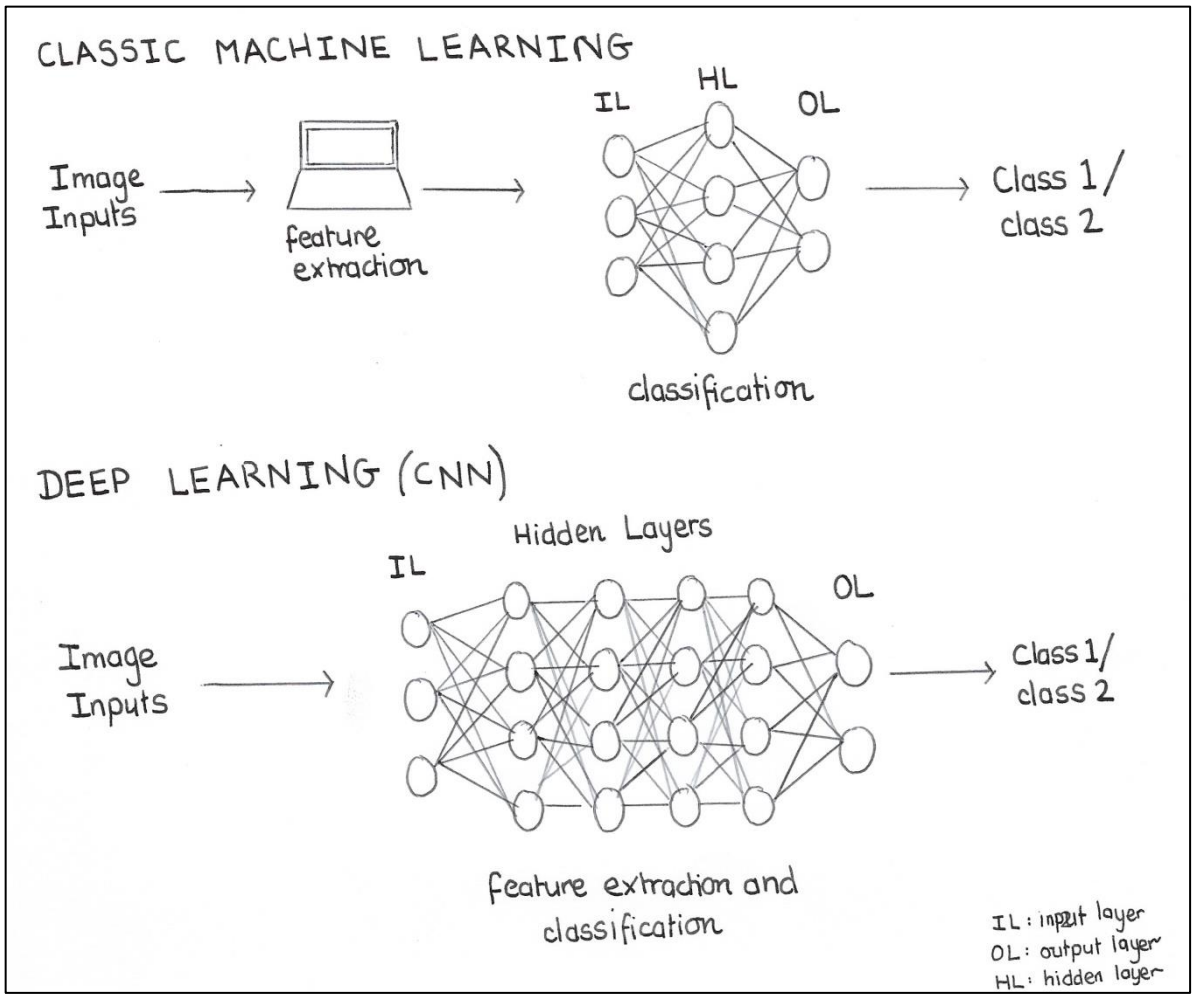

Figure 1

The success of AI in diagnostic dermatology isn't limited to melanoma. CNN have been shown to identify seborrhoeic keratosis, basal cell carcinoma and psoriasis[9]. Artificial intelligence has also been used to distinguish between Measles, German Measles and Chicken Pox which typically present with similar symptoms[10]; the study claims the CNN can recognise rashes and reach a prognosis faster than a doctor. Even nail disorders such as onchomycosis are diagnosed superiorly by CNN[11]. These groups plan to continue training their networks to recognise more skin conditions.

One of their goals is to produce a smartphone app to triage patients. However, the technology is still far off replacing a dermatologist. CNN require the input of high quality, detailed images, often dermoscopic, which a smartphone cannot replicate. A large number of images become 'unevaluable'[12]. In the images which are assessed by these apps there isn't sufficient accuracy and they are associated with a high likelihood of missing melanomas[12].

ACCESS AND INTEGRATION OF DATA

A great prospect for AI is the opportunity for surveillance. AI would be able to accurately document disease progression by comparing it to previous images. Acne severity can be graded in a 0-4 numerical range. AI evaluated 479 patients with acne achieving the correct grading with an accuracy of 0.85[13]. Software like this could be used to interpret acne progression and response to treatment. Apps such as SkinTracker already exist to allow a patient to document their disease progression however currently do not involve AI. Nance et al. showed that AI could be used in

the comparison of current and previous examinations, especially in radiological oncology follow up[14].

Another opportunity is the ability of AI to aggregate and access electronic medical records easily[15]. One of the main arguments against the use of AI is inability of the programme to treat the patient as a whole. However by being able to access a patient record AI would be able to cross reference other medical conditions, important especially in the context of drug interactions or contraindications. Even if AI doesn't replace a dermatologist consultation, a system like this could be used to save time trawling through notes, allowing reduced clinic wait times.

INCREASING ACCESS

Technology has already improved access to dermatology in remote areas via teledermatology. Clinical dermoscopic tele-evaluation was shown to have a high sensitivity and specificity in all diagnostic categories[16]. However a dermatologist is still required. AI offers the promise of a more standardised level of care, regardless of location or doctor. Non-dermatologists could consult with AI systems for triage and also improve training [17]. AI will decrease processing times thereby increasing the quality of patient care[18].

LIMITATIONS OF AI

PROBLEMS WITH CNN

CNN are not without their problems. Despite optimistic results there are still barriers preventing its integration into mainstream dermatology. Currently they

require massive data sets of high quality inputs which aren't always feasible to produce. Karen Panetta stated 'Getting the data is the biggest challenge, not the AI'. The largest data sets are also closed and restricted to a small number of institutions[6]. Most of the algorithms are fed by histopathologically diagnosed lesions[19]. Elmore et al. reported a disagreement rate of up to 75% between histopathologists when trying to differentiate between nevi with moderate to severe dysplasia and early melanoma[20]. Clinicians are able to account for this limitation and make decisions beyond the basis of morphology. AI which require clear end points between benign and malignant would struggle.

There are also ethical and legal implications for AI. Currently we cannot understand the complex method by which it generates its predictions. This may make AI difficult for patients and dermatologists to trust, hindering their acceptance. Once AI systems begin making autonomous decisions and stop being just a support tool, when something goes wrong, who is at fault[15] and will we ever be able to understand why the mistake occurred if we don't understand the process behind it? As the technology develops stringent sets of guidelines must be established. Another ethical consideration is the potential for racial disparities[21]. There are far fewer images of skin cancer on darker skin meaning the AI may underperform here as they don't have sufficient training. There is also the risk of missing acral or atypical melanoma[22].

IMPORTANCE OF HUMAN INTERACTION

AI does not compare to a dermatologists' consultation. AI algorithms only take into account the appearance of a lesion without context. Dermatologists use a lot more

information, crucially the clinical history and examination. While dermatology is primarily a visual speciality it is also a tactile one. Subtle melanomas may become more apparent with touch or stretch, and here AI cannot compete[23].

AI does not compare to true human intelligence. It lacks creativity and adaptability, which are crucial in tackling the great variation of people. Osler stated 'it is more important to know what sort of patient has a disease, than what sort of disease a patient has'. Ill patients want their physicians to be able to care for them, communicate clearly, be compassionate and express empathy[24]. Clinicians are able to do this and deal with a patient holistically, understanding their social relationships and normativity. Peabody observed 'one of the essential qualities of the clinician is interest in humanity, for the secret of the care of a patient is caring for the patient'. AI is unable to engage in high level conversation or understanding to gain the trust of their patients, meaning at present they cannot replace dermatologists.

A study into 'Algorithm aversion' found that humans were less tolerant of machines making mistakes than humans and believed that humans learnt better from mistakes than machines[25]. Human's ultimately prefer and trust another human more than AI, especially in medicine.

CONCLUSION

The potential for AI in dermatology is immense in prevention, detection, diagnosis and treatment. However, dermatologists' days are not numbered. AI can be used as a tool to aid the dermatologist, as well as eliminating repetitive tasks. It has been demonstrated that humans and AI working together achieve a higher level of accuracy in diagnosis and prognosis[26]. This is echoed by Jonathon Chen from the

Stanford Department of Medicine, 'Is the computer smarter than the physician? It's irrelevant. Together they can provide something better than either could alone'. The future seems to hold more promise for integrative decision support systems rather than a fully automated system (figure 2). AI will be able to clear the way for value added tasks such as more personal consultations with increased human-human bonding and treatment plans which match patient goals[27]. There will also be increased time for research to allow continued improvements for patients' health. I believe that AI will inevitably reshape the role of dermatologists, but dermatology as a speciality will continue to thrive, aided by AI.

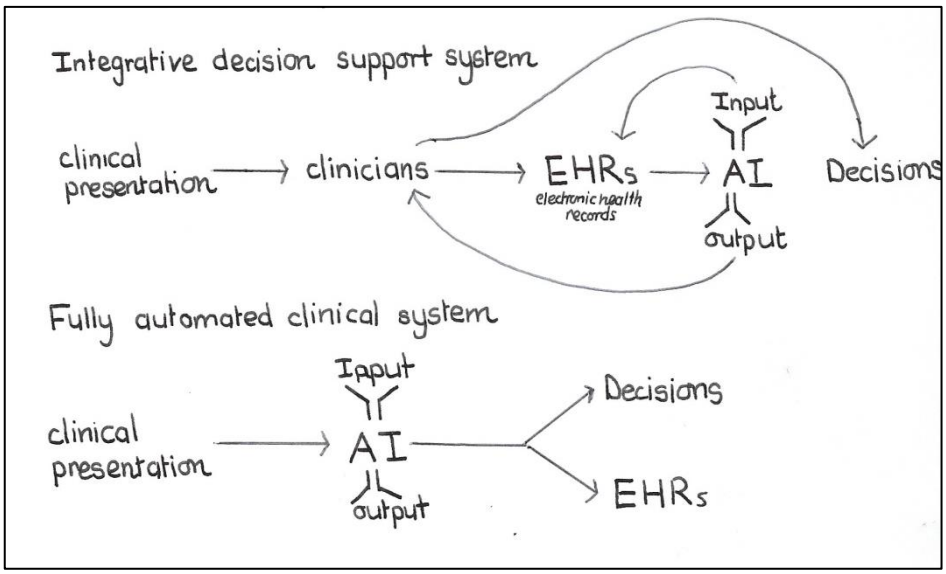

Figure 2

Words: 1498

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