



Artificial intelligence, machine learning, neural networks, and deep learning: Futuristic concepts for new dental diagnosis



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Technological advances in the diagnosis of dental diseases are not limited to the hardware and are no longer defined by microscopes and imaging sequences read and reported by trained specialists. The age of machine learning is here. Let us see how and why this is important. Dental second opinions are no longer limited to the next specialist in a different town. Research is now underway to train the next set of specialists: computers with artificial intelligence (AI).

AI can be defined as the theory and development of computer systems that are able to perform tasks traditionally done using human intelligence. Machine learning and deep learning are subsets of AI.¹ They explore the study and construction of algorithms that can learn from data and make predictions. Machine learning is a branch of computer science that builds algorithms guided by data. Deep learning is considered “machine learning on steroids.”¹ This advanced form of machine learning requires the use of artificial neural networks – algorithms inspired by the structure and function of the human brain. The human brain has upwards of 85 billion neural connections, and the deep learning AI neural networks have anywhere between a few thousand to a few million neurons spread over three layers: the input, the output, and the hidden layers.¹

The building block of AI is an algorithm.² Algorithms are a set of computer instructions targeted to perform a particular task. Machine learning involves building complex algorithms so the machine can learn on its own.² Machine learning applications can get refined with experience, unlike the traditional human learning process.

Although machine learning applications were introduced in the early 1980s, the complex computations required more computing power, which was not available at that time. The introduction of graphic processing units (GPUs) augmented this process of machine learning. According to Carestream Health,³ a leader in the field of digital innovation and imaging technology, machine learning technology is accelerating at a rate beyond Moore’s Law, with algorithms and models doubling in capacity every 6 months.

What can AI and its machine and deep learning algorithms do for diagnostic imaging?

Showcased at a recent Society for Imaging Informatics in Medicine (SIIM) conference³ were exhibits demonstrating new algorithms that are being created to calculate the density of bone captured with computed tomography (CT) imaging. This will perhaps enhance our ability to predict the outcome of implants that are placed within that bone, whether or not there are osteoporotic changes within that bone. The models were also used to predict a fatty liver based on liver density, and identification of emphysema based on the amount of trapped air in the lungs. Evolving to this level of preventative care requires not only expertise in imaging analytics to develop the algorithms, but also access to huge libraries of images. The algorithms need to analyze hundreds or perhaps thousands of radiographic studies in order to become more knowledgeable and more accurate. Can we use similar models to predict or diagnose dental disease? The answer is an absolute yes.



Efforts are underway to diagnose a common dental disease, dental caries, using two-dimensional dental radiographs, and efforts are also underway to include cone beam CT volumes to explore further. Deep Convolutional Neural Networks (DCNN) are being tested for a variety of detection tasks^{4,5} like identification of teeth and detecting dental diseases such as endodontic pathology and periodontal disease, and will invariably spread to other disease models in the future. The question we often hear is “Will the AI based algorithms replace the traditional dentist’s role in the diagnosis of dental disease?” Our answer would be no. Although, dentists could benefit from the added luxury of having a second opinion in nanoseconds using AI technologies that could bolster the diagnosis and eventually help the patients, the intention of AI is perhaps never to replace a healthcare provider.

Currently, medical or dental experts are liable if a diagnostic decision goes wrong, but it is hard to attribute liability to therapeutic recommendations made by AI. For example, Watson (www.IBM.com), the IBM supercomputer, is the tool that has been implemented in many hospitals to supplement a health professional’s ability to come up with the treatment plan. However, clinicians have raised questions about the utilization of AI in healthcare, and those questions need to be further discussed and examined⁶ before AI takes a more important role in making recommendations for disease diagnosis.

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