WILL ARTIFICIAL INTELLIGENCE CHANGE FUTURE OF DENTISTRY!

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Abstract

Humans have recreated intelligence for effective human deciding and to unburden themselves of the stupendous workload. AI can act as a supplemental tool to enhance diagnosis and treatment care but intelligent machines can never be 'human'. the sector of AI is comparatively young but has still come an extended way within the fields of drugs and dentistry. Hence, there's a requirement for the dentists to remember about its potential implications for a lucrative clinical practice within the future.

***IndexTerms* - AI , Neural Networks, symbolic logic , Hybrid Intelligent Systems, Dentistry.**

INTRODUCTION

With an enormous increase in the documented patient data, intelligent software for its computation has become a necessity.[1] Computer-based diagnosis is gaining momentum due to its ability to detect and diagnose lesions which may go unnoticed to the human eye.[2] The conventional approaches have provided much information, but are subject to limitations.[3]The deed of the constant search has given rise to AI (AI), which may be a highly evolved system capable of mimicking functioning of the human brain.[2] This review will give an insight into the present concepts and uses of AI in various fields of dentistry.

Artificial intelligence

Alan Turing, a young British polymath devised the Turing test to suggest that machines can use available information and reason to solve problems like humans. The term artificial intelligence was coined by John McCarthy in 19564 and it is defined as 'a field of science and engineering concerned with the computational understanding of what is commonly called intelligent behaviour, and with the creation of artifacts that exhibit such behaviour'.[5]

Common terminologies utilized in AI Machine learning (ML)

Machine learning is the subfield of artificial intelligence in which algorithms are trained to perform tasks by learning patterns from data rather than by explicit programming.[6] Machine learning techniques invariably involve parameter tuning with regards to the underlying technique, such as, the amount of neurons, layers or epochs during a neural network technique; membership function selection in fuzzy logic; population size, selection strategy, mutation rate, crossover rate in genetic algorithms as well as in the hybrid techniques that use fuzzy logic or neural network or both.[7] Various machine learning models, such as the Genetic Algorithm (GA), the Artificial Neural Network (ANN) and the Support Vector Machine (SVM), can actually ``learn'' and `be trained'' from the given data in order to execute many functions.[8]

Representation learning

Is a subtype of ML during which the pc algorithm learns the features required to classify the provided data. This does not require a hand labelled data like ML.[9]

Deep learning (DL)

The ML is a subset of AI, meanwhile, DL, in turn, is a subset of ML. That is DL is a facet of AI; the term deep learning refers to artificial neural networks (ANN) with complex multilayers. The distinction between deep learning and neural networks (NNs) like feedforward NNs and feed backward NNs lies in their characteristic. Deep learning has more complex ways of connecting layers, also has more neurons count than other networks to express complex models, with more computing power to train and further has automatic extraction of the feature.[10]This algorithm uses multiple layers to detect simple features like line, edge and texture to complex shapes, lesions, or whole organs in a hierarchical structure.[6]

Clinical decision-support systems (CDSS)

CDSS actually is any computer system designed to help healthcare professionals make clinical decisions through managing clinical data or medical knowledge.[11]Most CDSS have four basic components: Inference Engine (IE), Knowledge Base (KB), Explanation Module and Working Memory. The Inference Engine (IE) is the main part of any such system, containing the knowledge about the patient from which to draw conclusions regarding certain conditions. The knowledge used by IE is represented in the knowledge base and tools that have been created to facilitate the acquisition and elicitation of this knowledge. The collected patient data may be stored in a database or may exist in the form of a message and is known as the working memory. The last component, the reason Module isn't present altogether CDSS. This module is responsible for composing justifications for the conclusions drawn by the IE in applying the knowledge in the KB against patient data in working memory.[12]

Artificial neural networks (ANNS)

Artificial neural networks are highly interconnected network of computer processors that are inspired by the biological nervous systems.[13]McCulloch and Pitts (1943) invented the first artificial neurone using simple binary threshold functions. The next important milestone came when Frank Rosenblatt, a psychologist, developed the Perceptron in 1958 which worked on a multilayer feed forward mechanism. Another breakthrough during this technology came when Paul Werbos in 1974 introduced "backpropagation" learning.[5] Today this ability of the computers programs is getting used to "learn" from newer information to aid health care for data processing and knowledge representation.1

ANN consists of a variable number of artificial neurons or nodes connected in hierarchical layers: an input layer, one or more hidden layers, and an output layer. Each node, with the exception of the input neurons, receives multiple weighted inputs and produces an output that is usually a nonlinear function of the inputs.[14] A neural network 'learns' through repeated adjustments of these weights. Their ability to learn from historical examples, analyse non-linear data, handle imprecise information and generalise enabling application of the model to independent data has made them a very attractive analytical tool in the field of medicine. They have been used in the clinical diagnosis, image analysis in radiology and histopathology, data interpretation in intensive care setting and waveform analysis.[5]

Recent advances in neural networks

Recently, several variations of artificial neural networks gained attention like convolutional neural networks (CNNs) for image classification challenges and dilated convolutional neural networks (DCNNs) for sematic scene segmentation challenges. Two main classes of CNNs prevail for volumetric prediction in general: Tiramisu and dilated convolutional neural networks (DCNNs) data. Tiramisu based models like U-net shine at predicting dose volumes that tend to be spatially according to reference to anatomy, such the dose volume to a prostate. Dilated convolutional neural networks (DCNNs) utilize convolutions that jump information during their encoding stage, to assist extend their field of view. DCNNs are often useful for predicting dose which will be mobile with reference to anatomy, as in head and neck cancer patients. It is likely that these methods will also soon become common in volumetric dose prediction for head and neck IMRT (intensity modulated radiation therapy).15

Fuzzy logic

Fuzzy logic is the science of reasoning, thinking and inference that recognises and uses the real world phenomenon – that everything is a matter of degree. Instead of assuming everything is black and white (conventional logic), fuzzy logic recognises that in reality most things would fall somewhere in between, that is varying shades of grey.5

Evolutionary computation

Evolutionary computation may be a general-purpose stochastic global optimization approach under the universally accepted neo-Darwinian paradigm, which may be a combination of the classical Darwinian evolutionary theory, the selectionism of Weismann, and the genetics of Mendel. Among all the evolutionary algorithms, Genetic algorithm (GA) is the most widely used. It was first introduced by Holland (1975). A simple GA consists of a population generator and selector, a fitness estimator, and three genetic operators, namely, selection, mutation, and crossover. It has been receiving increased attention due to a series of successful applications in different disciplines like biology, medicine and different branches of engineering.16 It has better application in medical field where they work by creating many random solutions to the matter at hand.[6]

Hybrid intelligent systems

This synergetic system allows to accommodate common sense, extract knowledge from raw data, use human- like reasoning mechanisms, deal with uncertainty and imprecision, and learn to adapt to a rapidly changing and unknown environment. The advantages of those technologies are often combined together to supply hybrid intelligent systems which may add a complementary manner. Many different hybrid systems available and therefore the popular ones are ANNs for designing fuzzy systems, fuzzy systems for designing ANNs, and Genetic Algorithms for automatically training and generating neural network architectures.[5]

Applications in dentistry

1. In dental education: With the recent incorporation of AI in intelligent tutoring systems like within the Unified Medical system (UMLS); there's an enormous improvement within the quality of feedback that the preclinical virtual patient provides the scholars .[17]

2. ANN has sufficient precision for the planning and chairside manufacturing of dental prostheses, supported digital image acquisition following tooth cusps assessment. It can have an excellent potential in investigating the properties of dental materials like chemical stability, wear resistance, and flexural strength.[2]

3. AI in Patient Management: - It can assist in coordinating regular appointments and alerts the patients and dentists about checkups whenever any genetic or lifestyle information indicates increased susceptibility to dental diseases (eg: periodontal screening for patients with diabetes and carcinoma screening for those that habitually use smoked or smokeless tobacco).[1]

- It also can create a database about any relevant medical record or about any allergies that the patient may have. It can't only assist in clinical diagnosis and treatment but also provide emergency tele-assistance in cases of dental emergencies when the dental health care professional can'tbe contacted.[1]

4. AI in Radiology: - It are often integrated with imaging systems like MRI(magnetic resonance imaging) and CBCT (cone beam computed tomography) to spot minute deviations from normalcy that would have gone unnoticed to the human eye. this will even be wont to accurately locate landmarks on radiographs, which may be used for cephalometric diagnosis.[1]

- ML algorithm can detect a lymph gland in head and neck image as normal or abnormal provided it's trained Radiologist by analysing thousands of such images which are labelled as normal or abnormal.[9]
- ANN is found to act as a second opinion to locate the minor apical foramen, thereby enhancing the accuracy of working length determination by radiographs and in diagnosing proximal cavity . it's also found to possess sufficient sensitivity, specificity, and accuracy to be a model for vertical root fracture detection in digital radiography.[18]
- Wang et al. first presented a piece of writing that used DCNNs within the diagnosis and analysis of dental radiographs. additionally , Miki et al. conducted research that focused on classifying tooth types in dental cone-beam CT images via an automatic method of DCNN.[19]
- Recently, Lee et al. studied DCNN using computed- assisted diagnosis (CAD) system for the detection of osteoporosis on panoramic radiographs. The DCNN CAD system was compared to experienced oral and maxillofacial radiologist and therefore the results showed high agreement between the 2 .[19]

5. Dar-Odeh et al conducted a study to utilize ANN for the prediction of rather unclear entity of diseases termed as recurrent aphthous stomatitis.[20]

6. AI in Prosthetic Dentistry:- so as to supply ideal esthetic prosthesis for the patient various factors like anthropological calculations, facial measurements, ethnicity and patient preferences has been integrated by a design assistant, RaPid to be used in prosthodontics. RaPiD integrates computer aided design, knowledge based systems and databases, employing a logic based representation as a unifying medium.[4]

- With the assistance of AI , the pc can actually guide the dentist during the whole procedure of creating a digital impression and aid in making a perfect impression.[1]

7. AI in Orthodontics:- Diagnosis and treatment planning are often done by analysis of radiographs and pictures by intraoral scanners and cameras. This eliminates the need for creating patient impression also as several laboratory steps and therefore the results are usually far more accurate compared to human perception. The tooth movement and final treatment outcome are often predicted by using algorithms and statistical analysis.[4]

- It also can be wont to provide orthodontic consultations to general practitioners for the alignment of crowded lower teeth.[2]
- Seok-Ki Junga and Tae-Woo Kimb conducted a study to construct a man-made intelligence expert system for the diagnosis of extractions using neural network machine learning and to guage the performance of this mode. This study suggested that AI expert systems with neural network machine learning might be useful in orthodontics.19

8. Pain assessment: Xiao-Su Hu et al conducted a study where artificial neutral network (3-layer NN) achieved an optimal classification accuracy at 80.37% for pain and no pain discrimination.[22]

9. Head and neck cancer: Ibragimov and Xing were the primary to aim the utilization of CNNs for segmentation of organs in danger from head and cancer CT images. Their results confirmed that CNNs well-generalize the intensity appearance of objects with recognizable boundaries whereas additional information could also be required for CNN-based segmentation for the objects with poorly recognizable boundaries.[23]

- Another study was conducted which showed that genetic programming (GP) performed the simplest in carcinoma prognosis when the features selected are smoking, drinking, chewing, histological differentiation of SCC, and oncogene p63. it had been also found that the GP outperformed the SVM and LR in carcinoma prognosis. GP is additionally proved to be applicable in drug discovery.[u]
- Fuzzy sets are wont to predict cervical lymph gland metastasis in carcinoma of the tongue, for the prognosis of nasopharyngeal carcinoma, outcome prediction in esophageal cancer and for the prediction of carcinoma susceptibility.[24]
- The neural network could also be useful for the identification of people with a high risk of carcinoma or precancer for further clinical examination or health education.[2]

10.In periodontics: Lee et al. developed an architecture supported DCNN that consists of [16] convolution layers and two fully connected layers. The accuracy of their architecture in detecting periodontitis of premolars and molars was 81.0% and 76.7%, respectively.

- Further, Rana et al. presented an autoencoder framework with convolutional layers to segment gingival diseases from oral images. This model successfully distinguishes between inflamed and healthy gingiva.[19]
- ANN can also effectively be used in classifying patients into aggressive periodontitis and chronic periodontitis group based on their immune response profile. Therefore ANNs can be employed for accurate diagnosis of AgP or CP by using relatively simple and conveniently obtained parameters, like leukocyte counts in peripheral blood.[25]

11.Patcus. R et al conducted a study to guage facial attractiveness of treated cleft patients and controls by AI (AI) and to match these results with panel ratings performed by lay people, orthodontists, and oral surgeons and found that the results were comparable with the average scores of cleft patients seen in all three rating groups (with especially strong agreement to both professional panels) but overall lower for control cases.[26]

12Patcus. R et al conducted another observational study which illustrates that AI (convolutional neural networks) could be considered to attain facial attractiveness and apparent age in orthognathic patients.[27]

13.Forensic dental imaging: Personal Identification System Using Dental Panoramic Radiograph based on Meta_Heuristic Algorithm was reported to have an identification percentage approaching 97.7%.[28]

14.GAs and ANN are a promising tool for predicting the sizes of unerupted canines and premolars with greater

accuracy in the mixed dentition period and can also be optimized for predicting the tooth surface loss which may be a universal problem that involves an irreversible, multifactorial, non-carious, physiologic, pathologic, or functional loss of dental hard tissues.[2]
15.Another study was conducted with the objective of developing a decision support system for predicting the degree of color change after in-office tooth whitening by using colorimetric values. The patients' post-treatment color was largely close to the system prediction.[29]

Advantages of AI

1. Tireless performance of the tasks which saves time

2. Logical and feasible decisions without any involvement of human emotions which results in an accurate diagnosis

3. Standardization of procedure

Disadvantages of AI

1. The complexity of the mechanism[3]

2. The cost involved in the setup[2]

3. Enormous data is required for training and precision and therefore is it is difficult to achieve accuracy in rare conditions or diseases.

CONCLUSION

There are so many techniques that are being used in artificial intelligence and it is still in its budding stage. The prevailing researches have provided sufficient evidence of its efficacy. There is a common notion that artificial intelligence will replace the clinicians, which is why they have been quite skeptical in embracing it. As a matter of fact, the incorporation of these techniques will not only increase the efficiency of the specialists but also help in better patient care. It needs to be understood that artificial intelligence has been given birth by humans, therefore, it will never be able to enslave them in unfamiliar situations unless trained to do so.

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