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Review Article

Role of artificial intelligence in Dentistry- A Review

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ABSTRACT:
Artificial intelligence, or intelligent systems, especially deep learning, are machines that can simulate human cognitive processes to carry out learning and problem-solving activities. This area of study focuses on building computational models that have intelligence and thought processes similar to those of the human brain, as well as algorithms that can learn from data and generate predictions.

Key words: Artificial Intelligence, deep learning, Human brain

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INTRODUCTION

Artificial Intelligence (AI) term was coined by John McCarthy in 1956. He defined it as "the science and engineering of making intelligent machines." AI is the branch of computer science which deals with the study and design of intelligent agents that perceives its environment and takes actions which maximize its chances of success. AI may be defined as: "The ability to hold two different ideas in mind at the same time and still remain the ability to function". But AI must include the learning from past experience, reasoning for the decision making, inference power and quick response. Most popular AI analytic tool is used for image analysis inspired by the biological nervous system.[1]

HISTORY

One of the most important visionary and theoretician was Alan Turing (British mathematician), in 1936 proved that a universal calculator - known as the Turing machine - is possible. Turing's central insight is that such a machine is capable of solving any problem as long as it can be represented and solved by an algorithm. Creation of "The Logic Theorist" designed by Newell and Simon in 1955 can be considered the first AI program which marks the development of modern AI. John McCarthy in 1965 coined the term Artificial Intelligence.[2]

Machine learning (ML)

Machine learning is a branch of computer science that builds algorithms guided by data.

Deep learning

Specific form of learning based on algorithms of neural networks. Representation learning **Representation**

learning

Is a subtype of ML in which the computer algorithm learns the features required to classify the provided data. This does not require a hand labelled data like ML.[3]

Artificial neural networks (ANNs)

This involves a networks of highly interconnected computer processors that has the ability to learn from past examples, analyze non-linear data, handle imprecise information and generalize enabling application of the model to independent data thus making it a very attractive analytical tool in the field of medicine.[4]

Clinical decision support system CDSS

A Clinical decision support system (CDSS) is a system between a broad dynamic (medical) knowledge database and an inferencing output mechanism that are a set of algorithms derived from

evidence-based medical practice executed through medical logic modules. Currently, the intuitive interphase with voice controls are designed to assist the health care professional to work more efficiently with time saving and cost effective clinical dental practice.[5]

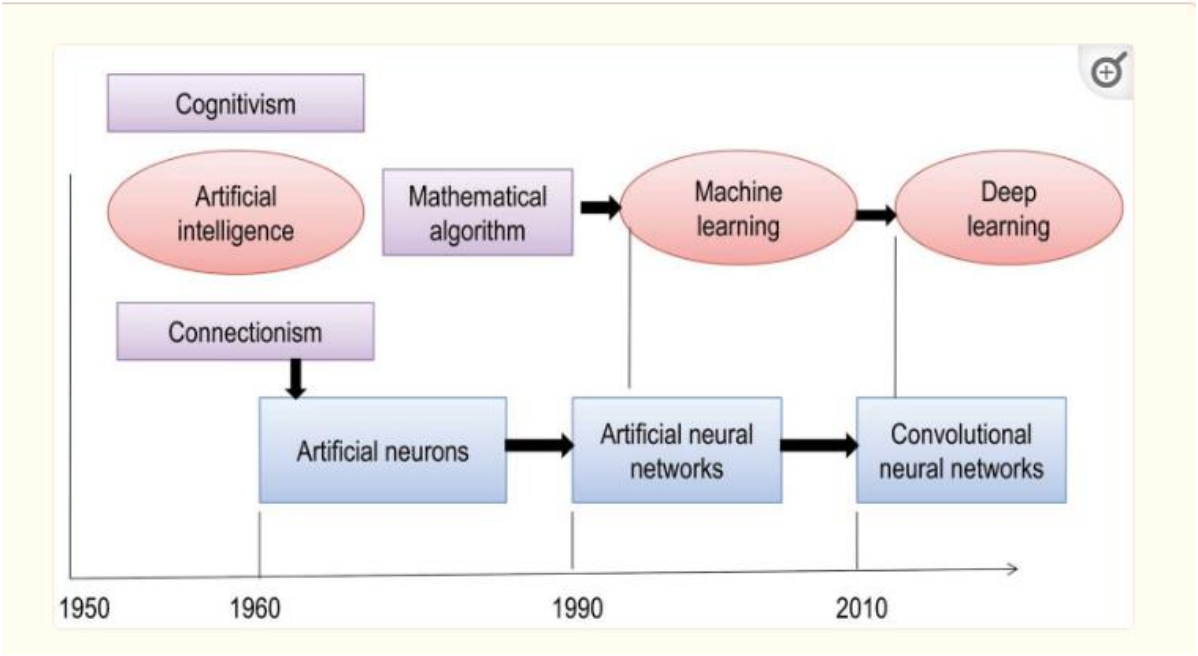

Fig- Artificial neural networks, depicts various approaches to intelligent systems from the mid-1950s to 2010 and the concepts of cognitivism and connectionism

Applications in dentistry

Virtual dental companions can assist in carrying out various duties in a typical dental setup with less effort and more accuracy. These responsibilities include scheduling visits, handling insurance and documentation, and alerting the dentists to the comorbidities and bad behaviors, such as alcohol and tobacco use. In dental crises, teleassistance might be helpful to the patient in case the practitioner is not present. Voice command can effectively regulate the chair placements, water distribution, and light control without requiring the clinician to manually enter any information.[6]

Oral Medicine and Maxillofacial Radiology

With the aid of AI, lesions of the oral cavity can be diagnosed and treated by screening and classifying them into suspected changed mucosa undergoing premalignant and malignant alterations.[7] Artificial intelligence may be able to predict the genetic propensity to oral cancer in a large population with accuracy. Artificial Neural Networks, or ANNs, can be used as an adjuvant diagnostic tool by dentists to identify subtypes of temporomandibular disorders, predict factors that seem to be connected to the occurrence of recurrent phatherous ulcers, predict the occurrence of BRONJ (Bisphosphonate-related osteoradionecrosis of jaw) in patients receiving bisphosphonates for the management of osteoporosis, and identify and accurately diagnose patients with various facial pain syndromes.[8,9]

Periodontics

Through the early detection of periodontal alterations, bone loss, changes in bone density, and the detection of peri-implantitis, deep learning analysis employing radiographs can aid in the diagnosis and treatment planning of periodontal disorders. This aids in implantology's early intervention. Based on their immune response profile, patients with aggressive periodontitis and those with chronic periodontitis can also be successfully classified using artificial neural networks, or ANNs.[10]

Oral and Maxillofacial Surgery

Artificial intelligence (AI) software aids with surgical planning by accurately preserving critical structures up to the last detail prior to operation, resulting in increased intraoperative precision. Image-guided surgery is one advanced clinical application that allows for more precise surgical resection and reduces the need for revision treatments.[11] Artificial intelligence is being used extensively in oral and maxillofacial surgery in tandem with the development of robotic surgery, which simulates human intelligence and body mobility.[12]

Orthodontics

In orthodontics, the diagnosis is the key component of treatment. By analyzing radiographs and photos, artificial intelligence (AI) assists with diagnosis, treatment planning, and treatment progress tracking. Dental impressions are now made digitally thanks to intraoral scanners and cameras, and the

aforementioned data is fed into the system.[13] Artificial intelligence (AI) software and set algorithms are used to predict tooth movements and treatment outcomes, as well as orthodontic treatment plans that include anchorage patterns and the decision to extract or not extract teeth. They also identify the factors that influence decision-making prior to orthodontic treatment and assess whether patients with malocclusion need to have their teeth extracted. Modern technology combined with customized aligner-based orthodontics can increase case acceptance.[14]

Oral oncology

Early diagnosis of cervical lymph node metastases and head and neck malignancies has been made possible by intelligent systems, which may influence the prognosis and choice of treatment for patients with these diseases.[15] The two imaging modalities that are most frequently utilized to detect cervical lymph node metastases and sentinel lymph nodes are CT and MRI. Convolutional neural networks have been shown to improve the accuracy of CT-based lymph node metastasis diagnosis (Ariji et al., 2017). Convolutional neural networks performed as well as professional radiologists, with an accuracy of 78.2%, sensitivity of 75.4%, and specificity of 81.0% in picture classification.[16]

Prosthodontics

When AI is used in conjunction with design tools, a dentist can create the most beautiful prosthesis possible while taking into account a variety of variables, including patient preferences, ethnicity, anthropological calculations, and facial measurements.[17] AI is crucial in determining the cortical thickness and kind of bone to create accurate surgical guidance for implant placement. By producing 2D and 3D models and eliminating human error, CADCAM technology replaces the tedious and time-consuming traditional casting process. One possible application of virtual reality simulation (VRS) technology is to model the facial profiles after therapy. This helps the dentist create the aesthetics effectively and serves as a tool for patient motivation.[18]

Forensic applications

Determining the victim's age and sex from skeletal remains is a crucial part of forensic examinations to identify victims at crime scenes. Given that teeth are incredibly resistant to decay and continue to function normally even after soft tissue and skeletal systems have broken down, forensic literature has demonstrated the value of using teeth to determine an individual's identification. Bewes et al[19] discovered that 900 anthropological skull reconstructions from CT scans had a 95% accuracy rate in sex differentiation using neural networks. While very few studies have looked into the use of neural networks for age assessment, intelligent systems may also increase the accuracy of age estimation techniques.

Advantages and limitations

By enabling automated segmentation, identifying patients at risk of cancer, detecting minute abnormalities within an image that may go undetected by the human eye, providing information on the functional performance of tissues and organs and the extent of disease, and facilitating early cancer screening, intelligent systems have lessened the workload of radiologists. The question remains whether radiologists will eventually be replaced by this technology, even with the benefits mentioned above.[20] While they have lessened radiologists' workloads, intelligent technologies cannot fully replace human intelligence. These systems necessitate an enormous knowledge base, and they may interpret images incorrectly when used in different situations, leading to false-positive or false-negative outcomes. Additionally, radiologists ought to receive training in biometrics, data science, computational techniques, and genomics to improve their use of this technology.[21]

CONCLUSION

In dentistry, intelligent systems are essential for providing prompt diagnostic and treatment recommendations for intricate issues. Artificial intelligence has countless clinical uses, and the field is still in its early stages with active research being conducted. The fields of maxillofacial radiology and general dentistry both have bright futures ahead of them.

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