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Artificial Intelligence and Machine Learning for Beginners in Dentistry

Rewant Chauhan* **and Saumya Tiwari**

Private Practitioner, Government Dental College and Hospital, Mumbai, Maharashtra, India.

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ABSTRACT

This paper is based on the various methods and advancements in the field of dentistry with the adjunction of machine learning models that have been deployed and are available to dentists; artificial intelligence is a technological advance with widespread applications, from diagnosis to the prediction of the outcome of the treatment in healthcare.

Keywords: Artificial intelligence, Machine learning, Algorithm, Models, Dentists

INTRODUCTION

Dentists use cutting-edge medical technology to provide better treatment for their patients. Before computers, keeping track of each patient's dental history and treatment plan was a time-consuming and laborious process known as dental charting [1]. Despite its seeming inefficiency, this process has gotten easier and more accurate in recent years thanks to the widespread availability of intraoral scanners and treatment planning software such as Pearl.ai [2] and Overjet.ai [3]. Using hundreds of data points and images in its processing code, these programs improve machine learning models [4]. Machine learning is the foundation of artificial intelligence (AI), or AI is the backbone of machine learning [5]. While the goal of artificial intelligence research and development is to improve machine learning [6]. There is a vast gulf between computer programming and machine learning, which is the statistical and mathematical modeling technique that does not require much coding to attain a result or aim through automatic learning and predictive analysis [7].

You need an input, a function, and an output to build a simple computer program [8]. This means that a coder or programmer is aware of the input and output that can be obtained by following a predetermined set of rules [9]. In contrast, machine learning relies on model training, wherein the more correlated data is introduced into the system, the more reliable or accurate it becomes. This is because machine learning is based on complex functions that are difficult to code, wherein the input and output need to be related to statistical data points, and wherein the computer itself creates a function that can create input and output pairs [10].

By means of intricate computations that could only be performed by a computer [11]. The most fundamental distinction between traditional computing and machine learning is that the former is predicated on the input and output being explicitly defined, whereas the latter is capable of learning its functions from data [12]. There are three primary models used in machine learning:

1. Supervised learning
2. Unsupervised learning
3. Reinforcement learning

- Supervised learning implies the system takes the pairs of input and output and links them to function; the better the model (input and output with functional relationship), the more correct the function it gets in respect to the input and output [13]. Since it approximates the function between input and output pairs, it is synonymous with the function approximator [14]. When presented with a problem, whether it be one of regression or classification, machines learn by systematically developing label types based on the situation [15]. It is more dependent on model training, which is based on labeled datasets. These datasets are then split into three categories: training, validation, and test. Decision trees, random forests, support vector regression, and so on are all examples of classic

Corresponding author: Rewant Chauhan, Private Practitioner, Government Dental College and Hospital, Mumbai, Maharashtra, India, Tel: 9767318838; E-mail: rewant.chauhan@gmail.com

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machine-learning algorithms used for supervised learning [16,17].

- Unsupervised learning is the process of finding correlations between unstructured data sets. Statistics such as age, gender, height, weight, etc. are examples of structured data, while images and text embeddings are examples of unstructured data. [18] These are the foundations of machine learning as we know it today. Deep learning, which is based on the hierarchical ordering of data or parameters into layers, underpins the majority of today's popular and widely-used machine learning models. This means that before any prediction is produced, features are continually multiplied and added to the outputs from the previous layer. [19] As a result, the features and prediction relation between the layers of the model become more intricate. The loss function tells us how well our machine learning algorithm estimates labels **(Figure 1)** [20]. To improve outcomes and prediction rates, every machine learning system works to minimize loss. In deep learning, there are various important concepts which are
- Cross-entropy loss the function determines the difference between prediction and probability [21].
- Gradient descent is the optimization of the algorithm to find good model parameters with minimizing the loss function **(Figure 2)** [22].

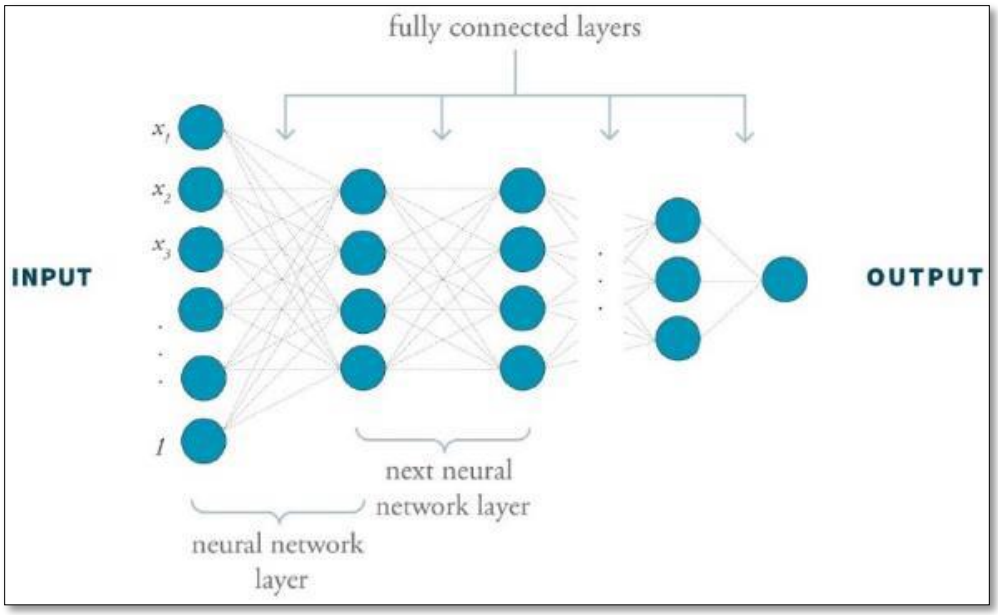

Figure 1. CNN Neural Network Architecture.

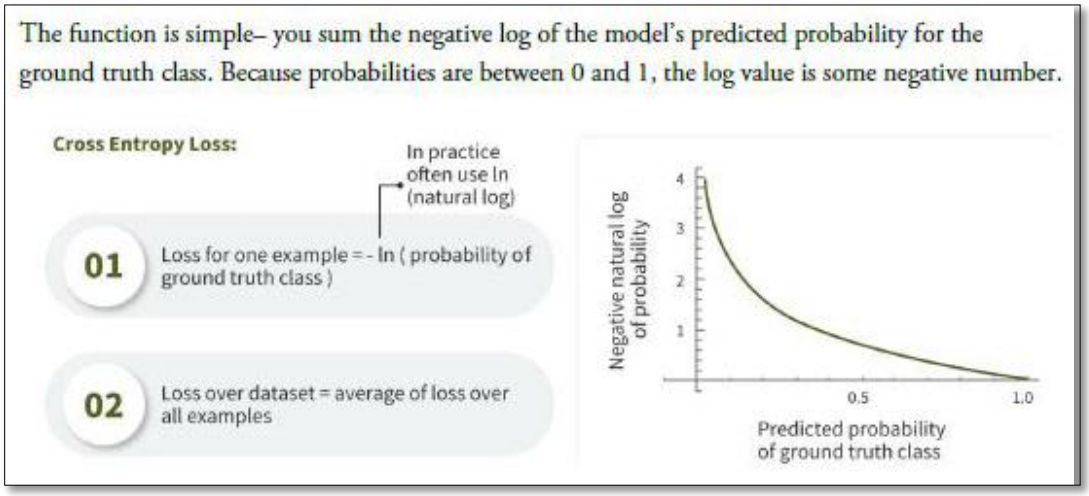

Figure 2. Graph Between Negative Natural Log of probability and predicted probability of ground truth class depicting cross entropy Loss function.

- Backpropagation it is the key technique of deep learning models in machine learning that breaks down the gradient computation into parts rather than a combined structure [23]. Types of Deep Learning Neural Networks and their Applications:

CNN's Convolutional Neural Network

Designed for an unstructured data set which has Image sets for detection

Uses in dentistry:

Histopathology: Detection of abnormal cells in a histopathologic section in relation to diseases [24].

Clinical diagnosis: Detection of any oral Lesion

Radiology: caries Detection, bone loss, unknown Radiolucency and Radiopacities [25].

CNN's Work by dividing the image into pixels and correlates them with the neural network in layers and achieves the results **(Figure 3)** [26]. NLP or Natural Language Processing Algorithm understands human languages and organizes them it not only recognizes the vocabulary but also the context behind the words [27]. ImageNet, Resnet and Google Le ne: Are a few CNN's which are based on semantic segmentation and object detection **(Figure 4)** [28].

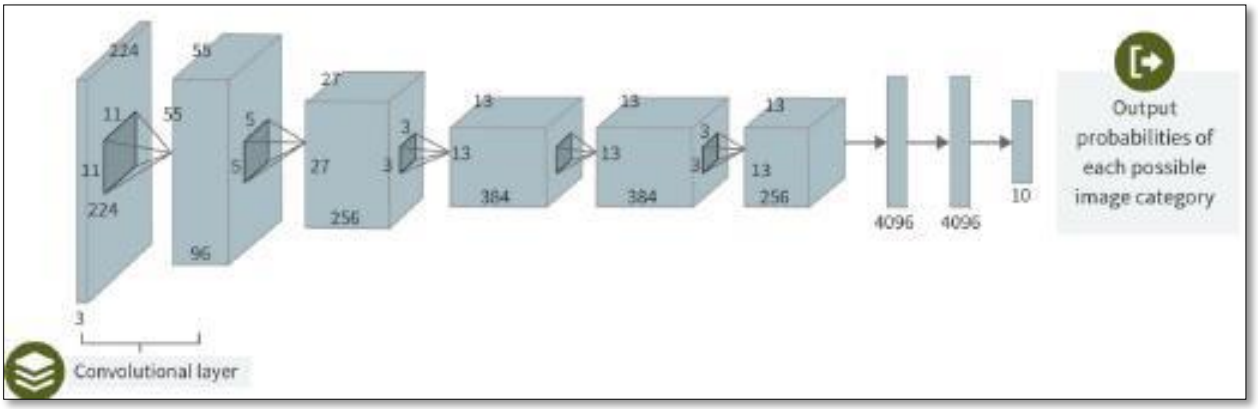

Figure 3. Convolutional Neural Network in Image Categorization.

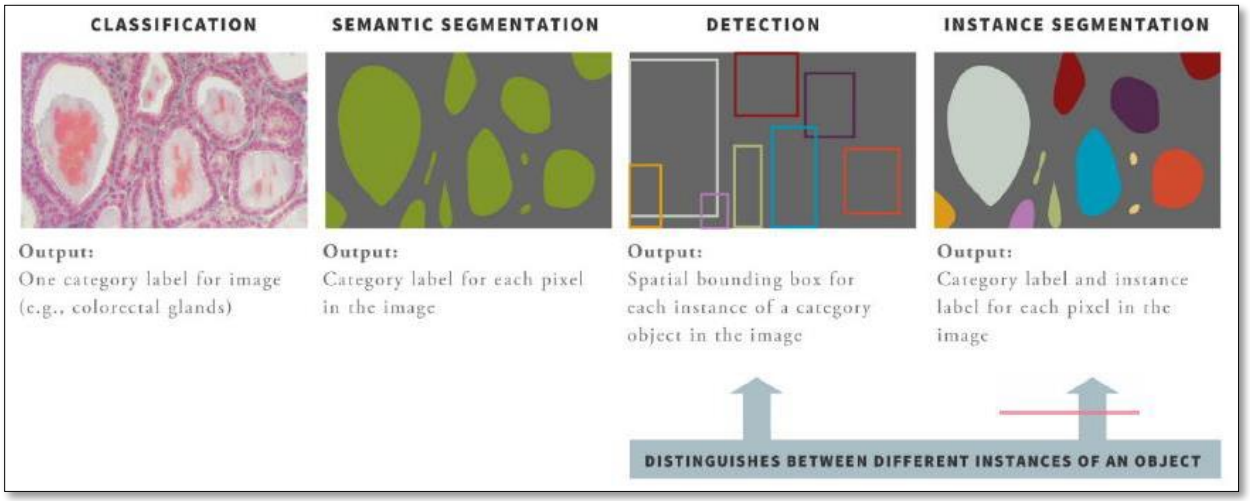

Figure 4. ImageNet, Resnet and Google Le ne: Are a few CNN's which are based on semantic segmentation and object detection.

- Reinforcement Learning: Because the model is built to anticipate outcomes using external agents and because there is no one best approach to excite the environment in practice, this area of medicine is relatively under-researched.

CONCLUSION

Exploration, discovery of new possibilities and outcomes based on existing data, and the development of other routes for more laborious conventional procedures are at the heart of machine learning. Dentists have access to a plethora of

data that can be mined for predictive models, then rolled out globally via user interface, put to work in low-resource environments, and used to provide patients with the best possible care.

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