How Artificial Intelligence Is Changing Dentistry

One of the growing topics of discussion in our profession is around the expanding use of artificial intelligence. The use of artificial intelligence (AI) is not new in health care applications. AI can be seen in robotic surgeries, image and data analysis and assisting clinical diagnostics. We are now seeing these tools expand beyond the typical hospital or primary care setting to include health care providers like dentists to create a new standard of care. We spoke with **Aadit Kapoor**, a San Francisco based full stack data scientist who is leading the effort to build A.I applications within the dental industry to learn more about the role of AI in this field of medicine.

Q. In simple terms what is AI and Data Science and what is their significance in dentistry?

Simply put, Artificial Intelligence is the simulation of human intelligence in machines. The term was coined by John McCarthy in 1955. In recent times, there has been an influx of A.I research which is driven particularly by increased computing and exponential data increase. Primarily researchers have worked on machine vision and language understanding problems. Data Science (DS) is the study of data to extract meaningful insights for the business. A.I and Machine Learning (A subset of Artificial Intelligence) are some of the techniques that could be applied to data to gain information or maximize a business impact.

Dentistry is a broad field and given its interdependence with technology, it is the perfect candidate for applying data science and artificial intelligence techniques to improve patient care. Broadly speaking, if there is adequate data and a defined business problem then DS and A.I can be extremely beneficial to the business. DS can significantly accelerate dental lab output via computer vision, OR (Operations Research), and predictive maintenance. From a dentist's point of view, A.I can be made to understand the designs of the intraoral scans, thus providing a faster output. Additionally, A.I techniques could be utilized for faster diagnosis and patient cost estimator via automatically estimating the probability of oral diseases. Technologies such as GPT or particularly language models can also be fine-tuned on 3D scans to increase and accelerate output. Another major benefit is AI's ability to standardize dental diagnosis and treatment. Dentists' evaluation of patient data is subjective, and research has shown that diagnosis is not always consistent between different dentists. Smart, new technologies in dentistry provide a way to significantly increase consistency, and as a result, improve patient health.

Data Science and A.I algorithms process huge amounts of machine data to predict/ recommend future solutions in an effort to achieve the 3P principle. The first P stands for Prognosis i.e identifying the root cause via data. The second P stands for Prevent, using past data to prevent future errors. The final P stands for Predict, using past data to predict future errors.
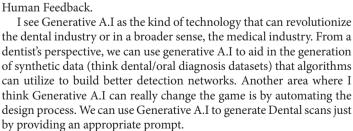
Q. **Could you please explain a bit about the ways in which AI has already been integrated into dentistry?**

A.I. is being actively integrated into dentistry from automating diagnosis to using A.I in designing crowns. A certain class of computer vision algorithms (such as Convolutional Neural Networks) is actively utilized to detect tooth decay, identify cavities, etc. Typically, we see an augmented form of intelligence where instead of replacing dentists, these services help or accelerate the radiograph diagnosis. Additionally, A.I assisted CAD/CAM design software utilizing A.I algorithms createsfaster design generation thus increasing lab output.

Q. **There has been a lot of buzz about "Generative A.I". Could you explain the significance of Generative A.I and how it can change dental laboratories?**

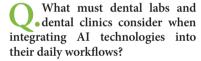Generative A.I refers to A.I algorithms (A.I algorithms typically used for unsupervised learning) that can generate text, audio, and images. These algorithms require a huge amount of data from which they can learn statistical properties and then can generate convincing text, images, etc. Services such as the now popular ChatGPT use Generative algorithms to first learn from past data, and using an initial seed, they can generate data of different modalities. Generally speaking, these services utilize an algorithm or a neural network architecture known as transformers (Generative Pretrained Transformers, GPT to be precise). Utilizing terabytes of data from different sources these networks cost millions of dollars to train using high-performance GPUs and utilizing techniques such as Reinforcement Learning from Human Feedback.

I see Generative A.I as the kind of technology that can revolutionize the dental industry or in a broader sense, the medical industry. From a dentist's perspective, we can use generative A.I to aid in the generation of synthetic data (think dental/oral diagnosis datasets) that algorithms can utilize to build better detection networks. Another area where I think Generative A.I can really change the game is by automating the design process. We can use Generative A.I to generate Dental scans just by providing an appropriate prompt.

Q. **What is the concept of Predictive Maintenance?**

Predictive Maintenance refers to utilizing data analytics to determine the condition of an equipment in order to estimate when maintenance is required. Predictive Maintenance typically utilizes predictive analytics or data science and A.I algorithms to be able to predict failure in the equipment. Common data modalities include sensor values, text log files, etc. Predictive Maintenance in the realm of the dental industry is extremely valuable as it allows users to quickly and effectively manage their machines and achieve higher mill output.

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Q. **What must dental labs and dental clinics consider when integrating AI technologies into their daily workflows?**

To be able to iterate A.I technologies in their daily workflow, the following are the most important ingredients of a successful A.I/data product:

1. Data Strategy: Building models is the easy part but collecting good quality and relevant data is the most important aspect of any data science/A.I project

2. Business Problem Formulation: Identifying where to apply such algorithms is an incredibly complex task. Dental labs and clinics should consider what problems to solve using data and should have a thorough analysis on what provides them with the most value.

3. Model Deployment and Metric analysis: Quantifiable metrics should be kept in place so as to measure the performance of an A.I system including both model specific and business-specific metrics.

4. Feedback system and iterate: Models or any A.I system should have a robust feedback system in place that can notify the developer/stakeholders of how it is affecting the organization. Rapid iteration and experimentation is also an essential part of integrating A.I technologies into their daily workflows.

Aadit Kapoor is a passionate full stack data scientist specializing in building end to end data driven applications with extensive experience leading million-dollar projects from scratch in various industries, including healthcare/medicine, logistics etc. Additionally he is spearheading the effort to build A.I applications in predictive maintenance at DGSHAPE, and his work was featured in the prestigious PyData Global 2022 Conference. He is based in San Francisco.