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CLINICAL TRAILS

Artificial Intelligence in Medicine

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Artificial Intelligence (AI) is a term that is increasingly heard and, let us admit, often evokes fear. AI is the ability of machines to perform tasks that typically require human intelligence, such as learning, problem-solving, and decision-making. This fear largely stems from subconscious associations with the domination of humankind by machines. In reality, however, this perception is misguided. AI represents a powerful tool-one that, when placed in capable hands, holds the potential to achieve remarkable outcomes.

AI can be defined as the ability of computers to perform tasks on data they have not previously encountered, through training. The concept of AI is not new. As early as 1998, LeCun developed the first model capable of recognizing handwritten digits. This naturally raises the question: why did it take nearly 30 years for the revolution in AI to materialize? The reasons are primarily practical. At the time, technology lacked the capacity to support the training of models requiring immense computational power. Today, such demands can be met. Additionally, advancements in research have been critical, with an extensive body of literature now supporting cutting-edge technology that was once in its infancy. Scientists have since developed highly capable models, and programming frameworks and libraries have been created specifically to support AI models.

AI encompasses several subfields, including machine learning and deep learning, among others with more technical designations. Machine learning is a subfield of AI where algorithms learn patterns from data and make predictions or decisions without being explicitly programmed for every scenario while deep learning is a specialized kind of machine learning that uses neural networks with multiple layers to analyze complex data (like images or text).

The core concept behind neural networks is the simulation of brain neurons.

Neural network is an algorithm inspired by the structure of the human brain, designed to recognize patterns and relationships in data. Numerous algorithms exist; each designed for distinct purposes.

In our daily lives, AI algorithms operate behind the scenes in ways we may not realize. For example, email spam filters use specific algorithms, as do YouTube video recommendations, friend suggestions on Facebook, and predictive text in email composition. Moreover, tools such as GPT and

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Copilot can generate text, images, and a vast array of user-specified content.

However, we must not be overly dazzled. These models are not infallible. On the contrary, they are prone to errors. While a mistaken response from a language model may be inconsequential, errors in critical areas such as medicine can have serious implications.

It is important to clarify that AI should serve only as an adjunct. It cannot-and must not-replace the role of the physician. Within this framework, we can examine specific areas of modern medicine where AI proves beneficial.

The field with the most significant application of AI algorithms is medical imaging. This is largely because, in computational terms, medical images can be represented as numerical data. AI algorithms can perform various analyses, including disease detection, organ segmentation for further analysis, spatial localization of pathology, and quantitative assessments. A major advancement is the development of radiomic biomarkers (Quantitative features extracted from medical images using AI that may not be visible to the human eye but correlate with disease) that can offer insights into clinical questions. How does this assist a radiologist in practice? For example, a radiologist with a high workload may benefit from an AI model that filters normal from abnormal radiographs, enabling focus on complex cases. Additionally, AI can flag regions of interest in detecting difficult-to-spot breast malignancies. Such software is already integrated into mammography, MRI, ultrasound, and other imaging devices from major manufacturers.

Beyond image analysis, AI has a role in pathology. With the development of chatbots, patients can interact with virtual physicians and receive preliminary diagnoses. These state-of-the-art models are regulated and approved by appropriate authorities.

Modern genetics has also embraced AI. Machine learning algorithms are uniquely suited to deciphering the complex relationships between genetic mutations (changes in DNA sequence that can affect health; AI is used to analyze these mutations for disease prediction or treatment planning) and disease. Another frontier is personalized medicine-customized treatments and analyses based on individual patient histories.

In cardiology, AI models can analyze electrocardiograms to detect pathologies. Cardiac ultrasounds, angiograms, and MRIs can be evaluated by AI to assist in therapeutic decision-making.

In ophthalmology, AI algorithms can detect conditions such as diabetic retinopathy. In under-resourced regions lacking ophthalmologists, a smartphone-equipped with a lens attachment and AI software-can be transformed into a medical diagnostic tool. In oncology, AI can suggest treatments tailored to the unique medical history and biological characteristics of each patient. This results in more personalized and targeted therapies, increasing the likelihood of success and improving patient quality of life.

In neurology, AI can detect Alzheimer's disease using MRI and CT images. It can also predict patient responses to medications and guide optimal treatment selection. In orthopedics, AI can identify arthritis, injuries, and musculoskeletal anomalies, and assist in surgical planning through simulation of anatomical areas of interest. In emergency medicine, AI models can analyze patient records to triage cases based on urgency, thereby prioritizing care for the most critical conditions. Lastly, a revolution is underway in modern pharmacology. Time-consuming clinical trials may be supplemented with virtual simulations, yielding faster insights into efficacy and adverse effects.

It is evident that we are witnessing an unprecedented technological revolution.

The application of AI in modern medicine is highly promising, yet it remains in a developmental stage with significant room for improvement. The critical question is: "Are AI algorithms reliable in such a vital field as medicine?" The answer is that much work remains before these systems reach full reliability. Nonetheless, we must not fear this advancement. Rather, we should embrace it as a transformative tool that will soon become indispensable.