# Applications of Deep Learning in Healthcare

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Artificial Intelligence (AI) is becoming increasingly important in the medical field. It provides predictive behaviors that can accurately analyze complex medical data. With AI integration into many fields of medicine, it is important for healthcare providers to understand its capabilities and limitations. Its growing popularity and presence in healthcare has caused widespread media coverage, allowing a wider percentage of our population to become aware of its great potential to help. However, these news stories are often hyperbolic and overestimate the power of AI in healthcare and ignore its potential limitations.

### How is AI related to Healthcare?

AI is a subset of computer science that places importance on creating intelligent systems that behave and react the same way humans do in making decisions. In fact, concepts and algorithms in AI find their basis in neuroscience research that aims to better model and understand human intelligence and behavior.

AI has been used to reduce error in and time to diagnosis. In a study done at the Radboud University Medical Center, 11 pathologists participated in a competition against a deep learning AI model. The researchers concluded that the deep learning algorithms achieved better diagnostic performance than a panel of 11 pathologists participating in the simulation exercise. This is not to say that AI should replace the work of pathologists, but rather that pathologists could wield AI as a powerful diagnostic tool.

The utility of AI in healthcare extends to diverse applications including assisting in robotic surgeries, easing administrative workflow, and analyzing radiological biomedical images.

### AI is a powerful diagnostic tool.

A study done at the National Academies of Science, Engineering and Medicine found that diagnostic errors can be attributable to 10 percent of patient deaths. AI can be integral in mitigating these errors and improving quality of care for the patient. In a meta-analysis done by researchers at the University Hospitals Birmingham NHS, it was concluded that deep learning could indeed detect diseases ranging from cancers to eye diseases as accurately as health professionals.

Image analysis in radiology has been a large area of application for diagnostic AI. With a large increase in the volume of medical images globally, specialists are being outpaced. AI has been seen as the tool to reverse this trend; as

a result, the AI-based medical imaging market is on track to hit $2 billion by 2023.

Consequently, image analysis has helped radiologists aggregate many aspects of imaging data, such as tissue shape, size, texture, and density which provides a quantitative frame for radiologists to base their analysis off of. As a result, workload is reduced on tedious aspects of radiology, such as segmenting structures, while the quality of the analysis given for each case improves.

### AI and Telemedicine

The applicability of artificial intelligence extends to specialties utilizing telemedicine. Telemedicine is the remote access to patient records and the subsequent remote diagnosis and treatment of these patients through telecommunication. Similar machine performance levels were seen using telemedicine as regular diagnosing methods.

In 2017, researchers at Stanford University created an algorithm to diagnose skin malignancy. When the algorithm was cross-referenced with 21 board certified dermatologists, the convolutional neural network (algorithm architecture) was able to classify cancer at a similar level to the trained dermatologists.

Other areas where AI is applicable include tele-radiology, tele-pathology, tele-dermatology, and tele-psychiatry.

Dr. Van der Heijden from the Academic Medical Centre in Amsterdam concluded that there was an 18% reduction in healthcare expenditure and 74% of in-person referrals were prevented when his research team performed a prospective analysis of teledermatology consultations in the Neth-

erlands. With its broad range of application, AI serves as a useful tool to allow physicians to provide better quality care to their patients at a faster and cheaper rate.

### AI role in diagnosing patients:

Dr. Xiaoxuan Liu, a researcher part of the NHS trust, distinguished that though there are a lot headlines about AI outperforming humans, it can at best be equivalent. Though some studies show AI edging humans just by a little bit, the scenarios that were given to the healthcare professionals did not include additional patient information they would have in the real world. Thus, AI should be a seen as a helpful, supplementary tool in diagnosing and treating disorders rather a replacement to the current healthcare providers.

### AI's role in the Pharmaceutical industry:

Over the past years, AI has been playing a growing role in the pharmaceutical industry, specifically in drug discovery and predicting drug interactions. AI tools can be used to screen and identify compounds for use. With millions of chemical compounds available, AI is sophisticated enough to identify viable drug combinations for use. Recurrent Neural Networks, a specific AI architecture, can generate chemical structures with predefined rules set for the algorithm.

There are challenges, however, that must be overcome. An AI-facilitated invention is considered to be a public domain and unable to be patented in most country's patent laws. As a result, many companies must go through an arduous process to copyright their intellectual property.

Another issue is patient security and confidentiality. Personalized medicine using AI requires the patient's genetic code to produce individual-specific drugs. Possible breaches in privacy is an issue of tremendous concern.

Large data sets also require efficient and fast computational capabilities. Further advances in AI and computing power must be made to produce better results in this field.

### Future implication and Ethics of AI:

The advanced technology used with employing AI systems "has tremendous capability to threaten patient preference, safety, and privacy," claims Michael Rigby in his article published in the AMA Journal of Ethics. Dr. Danton Char, assistant professor of anesthesiology at the Stanford School of Medicine, raises some concerns with the use of artificial intelligence in medicine. Dr. Char asserts that, "the data used to create algorithms can contain bias that could result in misleading clinical recommendations by the system."

Dr. David Magnus, director of the Stanford Center for Biomedical Ethics, points to three biases that can play into health data: human bias, bias introduced by design, and bias in the ways health care systems use the data. Drs. Magnus and Char's support scrutiny of AI in medicine to ensure that the "collective knowledge" of published literature and information taken by health care systems about patient health won't be used without considering the inherent human side of patient care.

With further incorporation and interaction of AI in the treating of patients, providers have been encouraged by ethics researchers like Drs. Magnus and Char to act with the core tenets of medical ethics in mind. Ensuring patient autonomy has been a major goal of ethics researchers to ensure that patients are not coerced or forced into a decision. Another facet of ethics, justice, is exercised so that all resources and treatments are distributed equally among all groups of society. Healthcare providers are also encouraged to adhere to beneficence, the intent of doing good for the patient involved, even when utilizing AI for the treatment of their patients.

### Final remarks on AI's involvement in healthcare:

Though the idolization of AI as the superior diagnostic platform seems appealing and inevitable on the surface, a closer look at its limitations shows a different story. With the increasing efficiency of AI predictive algorithms and the increasing reliance on AI systems for diagnostic aid, its legitimacy in a healthcare environment is a topic for debate.

There are fears of complete obsoletion of physicians by these "magic" algorithms, but that is not imminent. However, the role of the healthcare provider is changing with the increasing availability of AI tools. In the present, AI systems are encouraged to be used with scrutiny, with providers being cautious of overreliance on their efficacy to treat patients.

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