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Study on Artificial Intelligence in healthcare

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Abstract

Since the 21st century, breakthroughs in artificial intelligence, attempts to accomplish tasks that normally require human cognitive processes, have brought innovation and new possibilities in various fields. Healthcare, as a field using modernized equipment to obtain abundant and complex data, has benefited tremendously from the application of artificial intelligence technologies. This article discussed healthcare data analyzed by artificial intelligence. It also outlined popular artificial intelligence technologies and their application as well.

Keywords

Artificial Intelligence, healthcare, healthcare data.

1. Analysis and usage of healthcare data

Most outcomes, decisions, and results involve the analysis of healthcare data in diverse forms from various sources. Historically, the complexity of the data has limited the processing of the data that could only be performed by healthcare professions with adequate training. The sources of healthcare data include, but not limited to, screening, diagnostic process, and hospital laboratories. The data is mostly delivered in graphs, reading from measurement equipment, and medical notes.

Now, artificial intelligence devices have much to offer in analyzing healthcare data. Abounding data was used to 'train' artificial intelligence systems before their employment in healthcare industries. In the training process, artificial intelligence devices correlate features in the data and outcome of interest. Thus, the resulting models can identify those features and provide corresponding suggestions. In the current stage, the majority of the studies tackle the task by focusing on certain types of data.

Image-based diagnosis is one of the most successful domain artificial intelligence set foot in. [14] In the diagnosis stage, images that resulted from magnetic resonance imaging, X-ray radiography, tomography, etc. are assessed by radiologists. Besides radiology, visual examination is also a widely diagnostic practice employed in multiple fields, such as ophthalmology, dermatology, and so on. Imaging data can be converted into digital data for artificial intelligence systems to understand and manipulate. Thus, artificial intelligence can recognize complex patterns in imaging data and provide quantitative assessment in a more accurate and automated fashion. [1] For example, Gulshan *et al* developed an algorithm for detection of diabetic retinopathy in fundus photographs. The algorithm was validated using two data sets and had satisfying sensitivity and specificity. [2] Guimarães *et al* presented a model for detection of gastric precancerous conditions using esophagogastroduodenoscopy images and it achieved 93% accuracy. [3]

Genetic data is another focal point of artificial intelligence application. Like imaging data, results and data from genetic testing and studies can be interpreted effortlessly by artificial intelligence. Moreover, genetic data from previous studies, due to the complex nature of human genes, is sometimes too immense for human minds to analyze thoroughly. Therefore, artificial

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intelligence is suitable for this task. In this regard, Khalifa *et al* developed a novel artificial intelligence approach for tumor RNA sequence data analysis to classify different types of cancer. [4]

As mentioned previously, the majority of the studies is analyzing certain types of data. Nonetheless, there is emerging research that has made progress in analyzing comprehensive collections of data. For example, Ahmed *et* al pointed out the direction of a multi-functional machine learning platform for healthcare and precision medicine. [5]

Besides the AI friendly data, there are other types of data that cannot be easily understood by artificial intelligence systems, such as medical records, reports, etc. Naturally, additional efforts are required before artificial intelligence can handle these types of data. As a result, there are fewer applications on utilizing these types of data. For example, Fiszman *et al* evaluated an artificial intelligence system in extracting pneumonia related concepts in order to detect pneumonia. The performance of the system is similar to that of physicians. [6]

2. Artificial intelligence technologies in healthcare

Artificial intelligence is not a technology but a concept that consists of different algorithms and technologies. Two categories of those are more popular in healthcare applications than others.

The first technology that is widely employed in healthcare is natural language processing (NLP). NLP is the aforementioned and extra step we need to take when analyzing some data with AI systems. NLP is a methodology for translating narrative language into data that is comprehensible for AI. NLP in healthcare applications mostly involves text processing and tagging. The input data with narrative language is delivered in different formats, such as text, recordings, and manuscripts. Thus, the corresponding text processing approaches were employed, i.e., optical character recognition (OCR), speech recognition, etc. After the data input has been converted to digital data, keywords of interest, such as disease-related terminologies, were identified and features were extracted to construct structured data for further analysis. For example, Voorham and Denig evaluated an NLP method to extract clinical measurement data from electronic patient records. The extraction method achieved high accuracy with rapid processing time. [7]

The second technological category is the analysis of the structured data that researchers currently use. Machine learning (ML) is a set of techniques that build models to make predictions or decisions using training data. [13] There are numerous algorithms, and we will introduce some of them with significant healthcare applications.

Supervised learning is an approach to establish correlations between input and output from training data. In the healthcare domain, typical input includes baseline traits, data from the diagnostic process of patients, etc. and output is mostly disease related outcomes. The trained model can provide predicted outcomes which can aid medical professions or serve as a reference. [13] In the case of a model trained with supervised learning algorithms that uses previous patients' baseline information, their treatment plan, and medical outcomes as input data, the model can predict outcomes of current patients given their treatment plan or generate treatment plans that have best predicted outcomes. This supervised learning approach is widely employed in the precision medicine field as well as many other fields.

Neural networks are one of the most common algorithms used in supervised learning methods. Neural networks take advantage of statistical and mathematical models and assemble connectionist sets of artificial neurals. It is essentially a sophisticated tool that researchers used to train ML models. For example, Arabasadi *et al* developed a neural network-based heart disease detection model which achieved 93.85% accuracy, 97% sensitivity and 92% specificity. [8]

Deep learning is a more recent and intricate extension of neural networks. One can say that deep learning is a multilayer neural network. Since the core of neural networks is linear regression, the performance of neural networks could reach a plateau when some real-world variables are simply unpredictable by linear relationships. The need for a more powerful algorithm is fulfilled thanks to the surge of computing power and complex data sets. [10] Deep learning can handle more complex data with higher dimensional structure. [9] Healthcare is also benefiting from the development of this new tool. For example, Haenssle *et al* have proven deep learning convolutional neural networks (CNN) is better than most dermatologists in detecting and classifying lesions from dermoscopy images and other clinical information. [11]

3. future trends and challenges

Machine learning will continuously evolve and lead to the development of newer and more advanced algorithms. With the help of more powerful algorithms, artificial intelligence will be able to process more complex data, provide more assistance to medical professions, and even accomplish more tasks independently. Due to the automated and extremely reproducible nature of AI performance, AI applications are deemed to be suitable for repeating and time-consuming tasks, such as monitoring, mass screening, etc. The purpose of AI systems is not to replace human actions, but to optimize the healthcare workflow, so the precious resource can be used in a more productive and efficient manner.

Another future trend is robotics. Robots are artificial intelligence applications of the physical extensions to physical ability of human beings. As the advancement in robotics, we now have the robotic arms that possess the precision required to work as assistants in an operating room. [12] Traditional surgeries that are regarded as hugely time-consuming procedures can potentially be performed by.

Although the application of artificial intelligence has delivered promising utility, challenges from various perspectives lie ahead. From a technical point of view, there is a strong need for more and better data to train AI models unsatiated. Besides data issues in general, we are extremely lacking in rare disease data and data from different areas or incompatible sources. Thus, AI is powerless against rare diseases and struggles to generalize to a larger scale.

From both the social and legal perspectives, with the booming in research and real-world implementations, the regulation authorities are lacking in setting up standards to assess the application outcomes and regulate the field practices. Some efforts have been made to establish a standard for AI systems, for example, FDA has provided some guidelines for the industry. Yet, a thorough and systematic regulation is still far from establishment compared to ones that FDI sets for drugs.

4. Conclusion

Artificial intelligence has already brought paradigm shifts to healthcare and undoubtedly will bring more in the future. Employing AI technologies, the healthcare industry is benefiting from the assistance provided by AI in various fields. Whilst the potential of AI seems limitless, hurdles lie ahead. To overcome these challenges, efforts from researchers and the government are needed.

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