Application of Deep Learning in Big Data Analytics for Healthcare Systems

R. Mehla

The advancements in technology and digitalization in the healthcare industry promote the growth of tools like E-health and M-health, which are used at various levels in health promotion programs. The use of information technology and telecommunications in healthcare is referred to as e-health. Prescription renewals, online appointments, exchanging healthcare data and medical records via a particular program, and many more features are included. On the other hand, M-health is a sub-domain of e-health in which mobile devices are utilized to provide healthcare services. It involves using communication technologies such as smartphones, PDAs, tablets, and wearable devices such as smartwatches for health and medical records treatment and maintenance. E-health and m-health have several advantages, including the availability and accessibility of healthcare services, low distribution costs, customization, and real-time treatment of patients, among others. However, it is all achieved at the expense of massive data generated by these devices, which brings the new term big data.

Big data refers to the collection of enormous amounts of data, which could be structured or unstructured. However, in big data, it is the knowledge derived from it that is useful, not the volume of data. It necessitates the employment of tools and analysis methodologies capable of extracting meaningful insights from it at higher abstraction levels. Deep learning is a multi-layered framework that can learn from unstructured data, making it an effective tool for big data analytics. Deep learning's characteristics like self-training, self-learning, and adaptability make it ideal for processing and analyzing extensive data created by e-health and m-health applications. Patient monitoring, healthcare information technology, intelligent assistance, diagnosis, and information analysis and cooperation are only a few deep learning use in big data in e-health and m-health. Apart from these basic functionalities, a systematic use of the deep learning in a healthcare system is shown below in Figure 1 [1]. It consists of three main phases: i) creation of the digital knowledge base, ii) application of deep learning strategies in diagonis and selection of treatment, iii) development of the clinical decision support systems.

Health data isn't just for archiving and passing on to future medical fellows or professionals. It must be thoroughly analyzed to detect patterns that could be done by deep learning. The identified trend could be utilized to see any specific disease symptom ahead of time, which otherwise may not be possible by just involving humans. Deep-learning models have attained the accuracy equivalent to health professionals in various diagnostic tasks, such as distinguishing melanomas from moles [2], breast lesion detection in mammograms [3-4], and spinal analysis with magnetic resonance imaging [5].

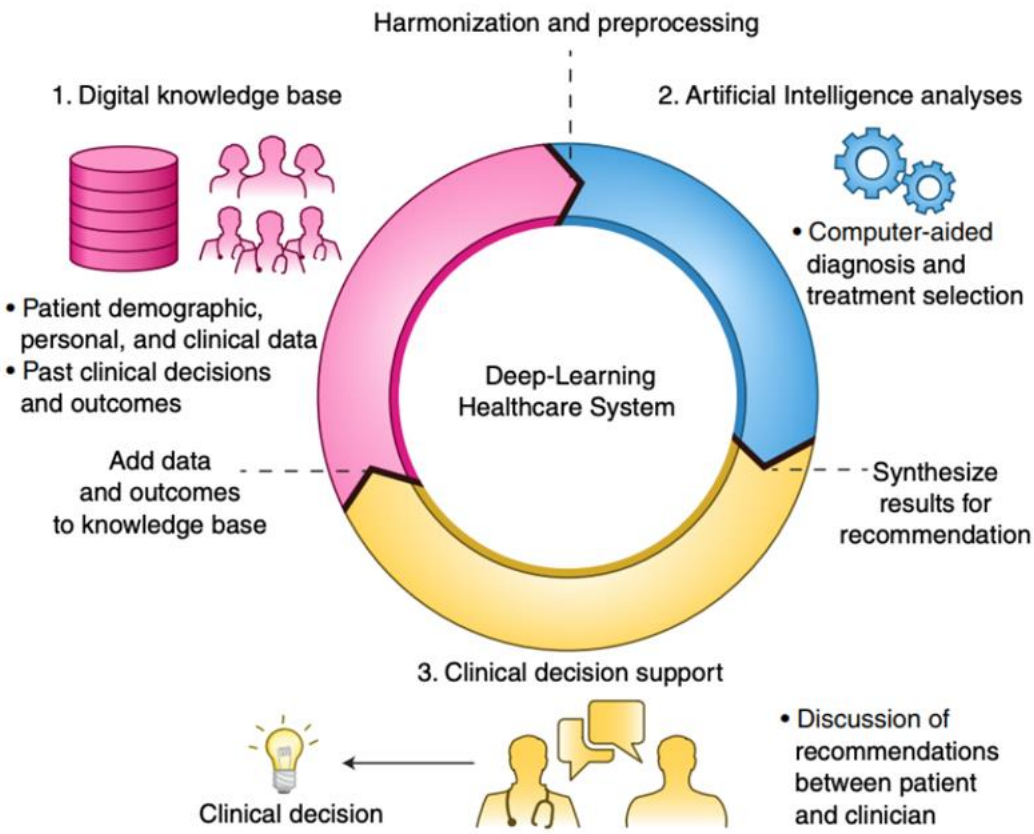

Figure 1. A Typical Deep-Learning Based Healthcare System [1]

There are different deep learning techniques like convolutional neural network (CNN) and recurrent neural network (RNN), which are becoming quite popular in the field of healthcare. CNN is mainly used in medical imaging to perform complicated diagnoses [6]. It is employed in various medical areas like dermatology, radiology, ophthalmology, and pathology. Image data is fed into CNN models, which iteratively warp it via a series of convolutional filters until the raw data is converted into a probability distribution across all possible image classes. RNN, a deep learning methodology, which is popular in analyzing large text, and speech data, also plays an important role in the healthcare domain. With the advent of e-health and m-health, electronic health records (EHR) are increasingly becoming prevalent. Doctors might end up spending more than half of the workday focusing on EHR paperwork, leading to fatigue and less time with patients. This could be mitigated by automated transcribing, using RNN speech to text translation in any language.

Notwithstanding these efforts, deep learning-based systems contain several errors and inefficiencies because the data in the healthcare field is exceptionally diverse, confusing, noisy, and incomplete. It's challenging to train an effective deep learning model with such large and diverse data sets [7]. Apart from that, there are several other challenges which are stated as follows:

- Understanding ailments and their variations are far more complicated than tasks like image or speech recognition.
- Diseases are continuously evolving and changing in unpredictable ways over time. However, most of the deep learning models assume static inputs, which become ineffective with time.

- The diseases are incredibly diverse, and we still don't know everything there is to know about the etiology and progression of the majority of them.
- Furthermore, in a real-life clinical situation, the number of patients is generally restricted, hindering the professionals from collecting more data and training an effective deep learning model.

All of these problems present several opportunities and future research options for the profession to develop. As a result, keeping all of these in mind, we propose the following directions, which we feel will pave the way for deep learning in health care in the future.

References

1. Norgeot B, Glicksberg BS, Butte AJ. A call for deep-learning healthcare. Nat Med. 2019;25(1):14-15. doi:10.1038/s41591-018-0320-3
2. Haenssle, H. A. et al. Man against machine: diagnostic performance of a deep learning convolutional neural network for dermoscopic melanoma recognition in comparison to 58 dermatologists. Ann. Oncol. 29, 1836–1842 (2018).
3. Cheng, J.-Z. et al. Computer aided diagnosis with deep learning architecture: applications to breast lesions in us images and pulmonary nodules in CT scans. Sci. Rep. 6, 24454 (2016).
4. Kooi, T. et al. Large scale deep learning for computer aided detection of mammographic lesions. Med. Image Anal. 35, 303–312 (2017).
5. Jamaludin, A., Kadir, T. and Zisserman, A. Spinenet: automatically pinpointing classification evidence in spinal mris. In International Conference on Medical Image Computing and Computer-Assisted Intervention 166–175 (Springer, 2016).