Deep Learning Model For Predicting And Detecting Overlapping Symptoms Of Cardiovascular Diseases In Hospitals Of UAE

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Abstract

Deep learning (DL) is a subdomain of machine learning (ML) representing exponentially growing potential in the field of medicine, helping to classify information, new diseases, phenotyping, and intricate decision-making. The DL algorithm and technique of an ML domain is often meditated by a variety of neural networks (NN). DL module has been augmented by on-going developments in computer tools as well as techniques. The use of this learning technique has been increased in various domains such as e-commerce, banking and finance, as well as for speech and feature recognition to learn and classify intricate information. There is no medical literature on the strengths and weaknesses of DL. DL strengths comprises of its potential to automatically diagnose clinical appearances, enhance decision-making, recognizing the phenotypes, and effectively select treatment methodology to complex diseases. The DL algorithm that can be well matched to chemistry is the hemodynamic and electrophysiological parameters catalogues that are effectively captured over continuous periods by wearable machines, as well as the division of images into captured images or pictures (Nagueh, 2016). However, DL has number of weaknesses as well, including difficulty in interpreting its examples (the 'black-box' criticism), its requirement for multiple training data, no specificity in design, no data-usefulness in training, limited use in experimental models, and so on. Hence, the best clinical applications of DL require considerate problem solving solution, selection of the most

suitable DL algorithms and information, and defining balance of outcome. This review updates the existing state of DL for cardiac physicians and researchers and gives diverse professions to escalate the pitfalls, close challenges, and opportunities for the currently available new area.

Keywords: Deep learning, cardiovascular, models, training, ML algorithms

1 Introduction

The heart is considered to be the most important organ of the human body, and it needs to be healthy and strong to perform the fundamental functions in the body. A heart is functioning as a center of a circulation system pumping blood and nutrients to the whole body. It supplies the necessary oxygen and releases carbon dioxide from the body. Articulation of blood is a living sign of the human body. The most common heart disease is the blockage of blood in the veins. The human diet is reflecting in a natural system of the body if a person doesn't have healthy eating habits, they might get infected with those diseases that can take up their lives. Cardiovascular disease that occurs due to fats remain in the body and get stored in the blood vessels and arteries, thus making the arteries hard and narrow. The fats inside the vessels clogs the flow of blood and create blood clots, due to which the normal function of the heart gets infected. The major type of cardiovascular artery is coronary arteries, which are the largest arteries of the heart and supply blood to the whole body.

Moreover, when these arteries contract, the heart muscles are restricted and can cause angina pain that is normally known as chest pain. The blood supply is essential for every organ, and the central nervous system is dependent on the supplement of oxygen and blood from the heart. When a heart stops supplying blood to the brain, it causes strokes, and brain cells begin to die, affecting the speech and talking ability of a person. Ligaments stop working and many other associated problems occur.

Cardiovascular disease can be detected at an early stage by checking the symptoms. If the patient's normal brain functions such as speech, facial expressions, rise in breathing while walking, are disturbed, then a traditional method to check heart's health formally known as electrocardiogram (ECG), is performed that records the electronic signals, which helps to point out abnormal heart rhythm beats. Other than ECG, a Cardiac-Computerized Tomography Scan is also used to detect heart operations. Cardiac Magnetic Resonance Imaging (CMRI) produces detailed images of the heart and its functions. The scan compares the results with normal functions and then identifies the issues and damage to the heart.

2 Literature Review

For the past few years, various researches have been done on using the machine learning algorithms for the prediction and classification for the heart diagnosis. In (Melillo et al., 2013), the author has described about the automatic classifier that detects the congestive heart failure illustrating the high and low risk heart disease of the patients. The author has used ML algorithm known as CART (“Classification and Regression”) with the help of which sensitivity is gained

nearly about 93.3 % and that of specificity is obtained by 63.5 %. In (Rahhal et al., 2016), author has enhanced the performance of ECG ("electrocardiogram") using the deep neural network that tends to have the ability to opt for the best feature then apply these feature to measure the performance of ECG.

In (Guidi et al., 2014), "clinical decision support system (CDSS)" has been used in order to detect the cardiovascular failure, such that it can be protected at early stages. Author of this research has compared various ML algorithms and DL techniques such as artificial neural networks (ANN), random forest (RF), and support vector machine (SVM) as well as CART model. The accuracy that can be achieved by CART and random forest is 87.6 percent, outperforming the accuracy of all other classification models.

In (Zhang et al., 2017), researcher has compared natural language processing (NLP) with that of the rule based approach. This model has the potential to provide results with the accuracy of about 93.7 % on setting up the NYHA HF model with the help of unstructured clinical data.

Deep learning (DL) is a new component in research development systems. Its motivation is to establish and model a neural community for the researchers and scientists interpreting the statistics in logical and algorithmic way. Deep learning algorithm makes use of a logical way to evaluate the information. The reason behind implementing DL algorithm is to make researchers of neural community to perform the procedural and statistical interpretation in an effective manner. In the brain, DL refers to neo and synapses such as the construction of neural network blockchain and the way community processes mimic DL images in a system, and DL refers to the permitting of traits to beneficial algorithms in the brain. Training and Knowledge based development (KDD) is applied in a system in order to understand the neural network models. Deep learning algorithms is widely used because it outdates the traditional and outdated systems and methods and widely promotes the development of DL structure, methods, and techniques for its multiscale study in changing professional sciences (Elsheikh, 2021)

As stated earlier, DL is one of the sub domain of ML algorithm. It is changing and showing promising results in many fields, also creating wonders in the medical field. Those deep learning algorithms that are especially used for classifications and prediction are deployed to detect diseases and cancers. The use of multi-layered neural networks has the tendency to detect those diseases that cannot be captured through traditional methods. Deep learning is a suitable technique for cardiovascular disease detection (C et al., 2019). Clustering analysis is helpful to predict from unsupervised learning methods, as well as multi-layered neural networks can distinguish from ECG and display activities of the heart. Deep learning models are not only excelling in detecting cardiovascular diseases but also improving the risk factor of cardiovascular diseases created from retinal fundus (Poplin et al., 2018). The diseases such as melanoma and diabetic retinopathy are being discovered from the medical imaging dataset. These images are evaluated by DL algorithms through clustering and classification method and disease results are

processed. Mapping interactions also show that neural network models focus on retinal vascular regions to predict many variables associated with heart disease (K et al., 2018).

It is becoming an essential concept in medicine to speed up the disease processing analysis for scientific diagnostics. Now, in order to evaluate and process the critical health diseases, the processes involved in DL model are of significant importance in scientific imaging phenomenon. In addition to these, considering the medical literature, DL has its key place to research about the domain of medical. The real-world and discrete application of DL in scientific prediction is quite trivial, and it is a completely new field that have several demanding situations. Effective assessments of clinical photography are first-class pain in the prognosis of the disease, and in addition, it is necessary to improve diagnostic techniques. At this level, DL should be considered a black container that requires information about its internal work and therefore provides some key technical issues that further requires procedural improvement. After that, with the appropriate diagnostics, the preoperative automated simulation planning for the use of appropriate generation of surgical interventions can be completed. This paper offers essential questions about the diagnosis of cardiovascular diseases, the use of this efficient and no longer properly understood technology. The mentioned problems are broken down into modular aspects of DL when it comes to photo categories, segmentation, and detection. This data is vital for the identification of similar diseases. Today the use of DL in data is primarily based on clinical pictures, missing property, and other relevant problems for hospitals (Aj, 2016).
The heart vaccine produces a wealth of biomedical, clinical, and operative information that is part of patient care. These records are often stored in various data warehouses that are not easy to use and are possible for heart failure research due to challenges in automatic abstractions and technical qualifications of the visual inspection manual. Despite these challenges, the use of technology for the internal teaching of the heart vaccine is not new. Scientists have long used Scion computers and fast AI-derived methods to analyze and interpret cardiovascular phenotypic data, such as automatic ECG analysis and imaging.
DL algorithms can also discover subtleties in clinical images that may be overlooked by physicians and project how they can have a significant impact on evidence that is far from all. Therefore, the actual impact of DL on clinical diagnostic classifications remains emerging and is relatively complex (Poplin et al., 2018).

The neural networks are a set of algorithms that are developed to work like a human brain, and it is designed through inputs in a way that generates or predicts output as a human brain cell predicts. The simple architecture of a neural network requires input, an activation function through which output generates (Wang, 2003). Activation functions are the core part of the neural network. The activation function is calculating the inputs that decide weight and bias. The primary purpose of this term is to maintain non-linearity in the output of the neuron. Another method of evaluation is the implementation of neural network models with the given data, the loss function that captures the predicted deviation in an algorithm. And, lastly, the optimizers are used to update the weights, in case, if the model is not performing as desired (Choi et al., 2019).

Neural networks are designed to predict models on which the data is tested and trained. Moreover, it is necessary to know about the core concept and related terms of neural networks and deep learning. The neural networks of different types and functionality will enhance 5G's different data related to it by using different activation functions, optimizers, libraries, and APIs. Deep learning contains pre-trained models that can be used to save computational complexity and saves time. Cardiovascular disease detection can use AlexNet, a type of convolutional neural network model (Alom et al., 2018) (Filippov et al., 2017), VGG Network (Qawaqneh et al., 2017), Inception Net (Xiong et al., 2018). Pre-trained models are beneficial to incorporate in a neural network structure. They are pretty fat in performance and do not require much-labeled data.

Hence the deep learning is producing an immersive contribution towards medical and specifically cardiovascular disease detection, but it has multiple challenges towards its rapid growth. The deep learning algorithms have always been criticized in the medical context and cannot even be explored from hidden layers. The analysts describe the deep learning algorithm as having less accuracy, and the interpretability of deep learning models is challenging and limits the performance. The quality of data while training and testing process can convert the performance of the models, and they are limited to produce biased predictive results. The choice of data matters before training the model (Kuzovkin et al., 2018).

Deep learning collection garnered significant progress in many types of applications. This new one, the field of machine learning, has flourished, and for a long time, used in many common areas, as well as some new areas have more opportunities. Different methods are designed based on different classes of education, including observable, semi-observable, and non-observable education. Sample acceptable results of images having descriptive evidence can be compared with that of the conventional knowledge that is obtained from field of computer vision, introductory speech, eye interpretation, reception, treatment description, etc.

2.1 Artificial Neural Networks

Artificial neural networks (ANNs) are computational methods which model the working behavior of the brain system and nervous system in production records. Various ANN's architectural structures have been presented in the literature as analytical tools for solving a variety of engineering problems (Elsheikh et al., 2020). An emblematic ANN model consists of a large number of interconnected neurons of interconnected and synaptic weights. Most ANN models include three categories; input, hidden, and output.

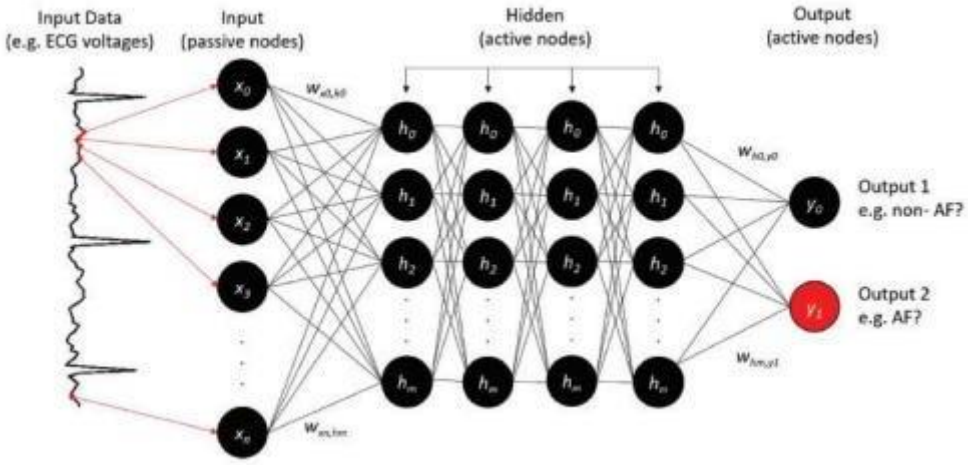

Fig. 1. Artificial Neural Networks (ANNs) (Abd Elaziz M., 2020)

The training procedure and approach of the DL algorithm and its model is achieved through the use of an adaptive method, such as a "stochastic gradient approach", and "synaptic stresses", these are renewed through posterior implantation methods. The key benefit of the model over other number-based analytical methods is its ability to perceive complex behavioral parameters of a particular system without being involved in solving complex mathematical modeling problems (Elsheikh, 2021)

Implementation of deep learning in future clinical trials allows comparing with routine care to thoroughly perform evidence, risk assessment, and self-treatment. Various machine learning methods such as supervised and unsupervised learning, knowledge based learning, and non-learning methods involving deep-learning can obtain the hidden structure present in a lot of information of cartography. Subdomain of this field can help to figure out common complications in cardiovascular disease; such perspectives can lead to new and available treatments effectively helping to provide your own Cardiac Care. As there are strong arguments in medicine about DL because of recent medical changes, ML algorithm and techniques has the potential to improve patient lives, provides better services, to public and society as a whole.

3 Methodology

The subsections below describe the approach that was used to detect and predict the cardiac disease in individuals in hospitals of USA.

3.1 Proposed Approach

The main objective of this paper is develop such a system that predicts and detect the cardiovascular disease in the individuals at early stage using the DL algorithms. For this purpose, two types of feature selection approaches were applied in the dataset. These feature selection techniques were mRMR, and FCBF to remove the redundant, noisy features and opt several features, such that they enhance the overall performance of the proposed method. The ML and DL algorithms used were including, KNN, ANN, SVM, RF, NB, LR, etc. In addition to them, various computational metrics were also computed to evaluate and measure the classification

algorithm's performance. The proposed methodology of the system was carried out in 5 different steps involving, dataset processing, Feature selection, cross-validation approach, Classification techniques, and Classifier's performance evaluation. The proposed framework of the system is as follows in Fig. 2 below:

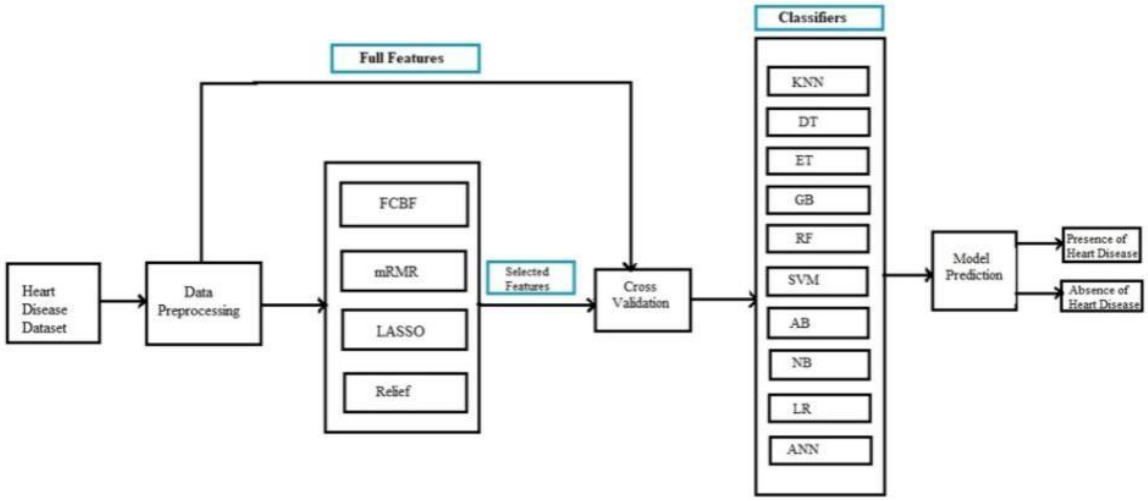

Fig. 2. Proposed Framework

3.2 Data Preprocessing

This process was done to change the raw data into some meaningful patterns. This step is considered to be crucial so that the data can be represented in a good form. Several processing methods, like, removal of missing values, standard scalar, and Max-Min scalar were used on the acquired dataset to shape it into more usable data for performing classification algorithm on it.

3.3 Proposed Algorithms of Feature Selection

FS selects the ideal features among every features within the dataset. Like data preprocessing, it is also considered to be of significant importance, this is because performance of the classification algorithms degrades owing to irrelevant features within the dataset. Tis helps in improving the classification techniques as well as minimizes the execution time. The details of the selected feature selection algorithms for the proposed method are as follows:

- *Fast correlation-based Filter (FCBF):* It follows the "sequential search strategy". At first, in this technique, full features are selected, after which symmetric uncertainty is used to measure the feature dependencies on each other as well as their effect on the output of the target label. Then the most significant feature is selected by making use of the backward "sequential search strategy". This feature selection algorithm is used on high dimensional datasets.
- *Minimal redundancy maximal relevance (mRMR):* This is based on heuristic approach that selects the important feature having minimum redundancy and maximum relevance. This approach chooses features that are relevant and useful to target output. Being

following heuristic approach, it checks only one feature one time, and them calculates its "pairwise redundancy" in comparison to other features.

3.4 ML and DL Algorithms

Several ML and DL algorithms were used, particularly ANN, for early prediction and detection of heart disease, in this proposed method. Even though each of the classification algorithm had its own results, but main focus was given to the results obtained from ANN classification algorithm. Other classification techniques that were used included: Random forest, Linear regression, Support vector machine, Naive Bayes, decision tree and neural network.

3.5 Performance Evaluation Metrics

To evaluate the performance of the ML and DL algorithms in proposed approach, various evaluation metrics were used including: f1-score, accuracy, specificity and precision.

- *Specificity*: It is calculated by measuring the ration among the classified health individuals to the actual number of healthy people, and its formula is as follows:

$$Specificity = \frac{TN*(100)}{(TN+ FP)}$$

- *Precision*: It is the ratio between the actual +ve score and +ve score that is predicted and detected by the DL algorithm, which can be calculated by:

$$Precision = \frac{TP*(100)}{(TP+ FP)}$$

- *F1 score*: It is the weighted measure of sensitivity and precision ranging between 0 and 1. 1 indicates the good performance of DL algorithm while 0 indicates the bad performance.

$$F1-score = \frac{2*(Precision*Recall)}{(Precision+ Recall)}$$

4 Experimental Results and Analysis

Available dataset was divided into different categories for training, demonstration, and validation. Another important factor in bringing the enhancement in DL algorithm was to take data that was still being scaled or adjusted (time sequence or where to see impatient accumulations). However, these were useful areas of study in the organization of the DL. Other information on samples from the patient for integrated data (e.g., multiple rues) were included as one of the vital stipulations for a treatment plan; the reason for the detection venture was to discover the vicinity related to the signs and symptoms of the ailment. In reaction to the low resolution, new technique for the automatic detection of coronary (M et al., 2019), thoracic aorta, and Volvuli calcification changed into setting up through using consecutive Artificial Neural Networks (ANN) (Alom et al., 2018).

The first ANN identification and, marking calculator ability based on its anatomical location, in particular, the use of a range of advanced systems to sell large field applications, allowed high-density voxel signals to be studied and used. The second ANN then gave the correct signal to the candidate. Only class classified voxels that used the first ANN were categorized as TP (true positive) or FN (false negative) proof of evidence using the second ANN. In other methods of performing certified work, the actual phenomenon is usually first noticed. The ANN no longer intends to lay hands and enter the spatial activity option, with the spatial history in 3 orthogonal 2D pieces believing more division of the signal system based on ANN. (Anon., 2020).

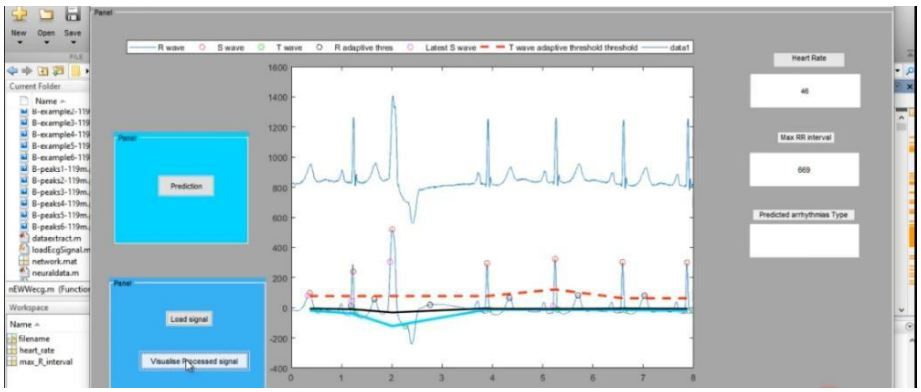

Fig. 3. Impatient Accumulations

Configuration of multi-class signal was done on QRS signal 5, for which the following results were obtained as shown in Fig. 4 below.

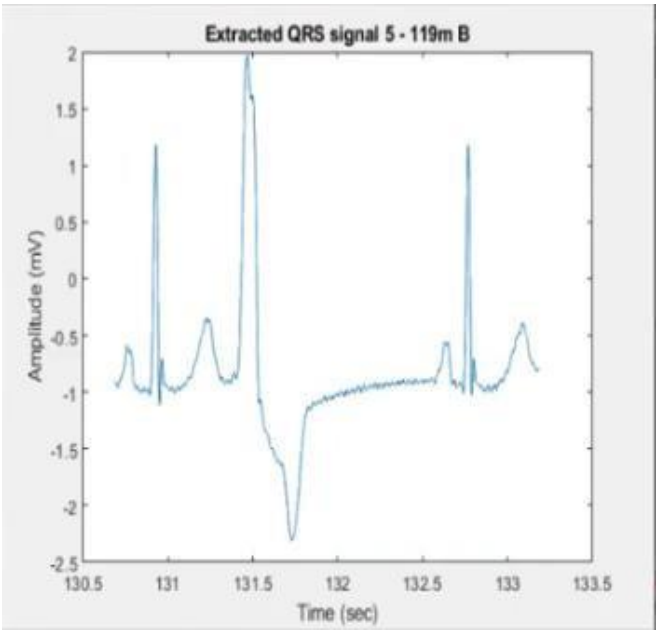

Fig. 4. Configuration of Multiclass signal 5

The configuration of the multiclass signal for signal 3 was obtained as shown in Fig. 5 below:

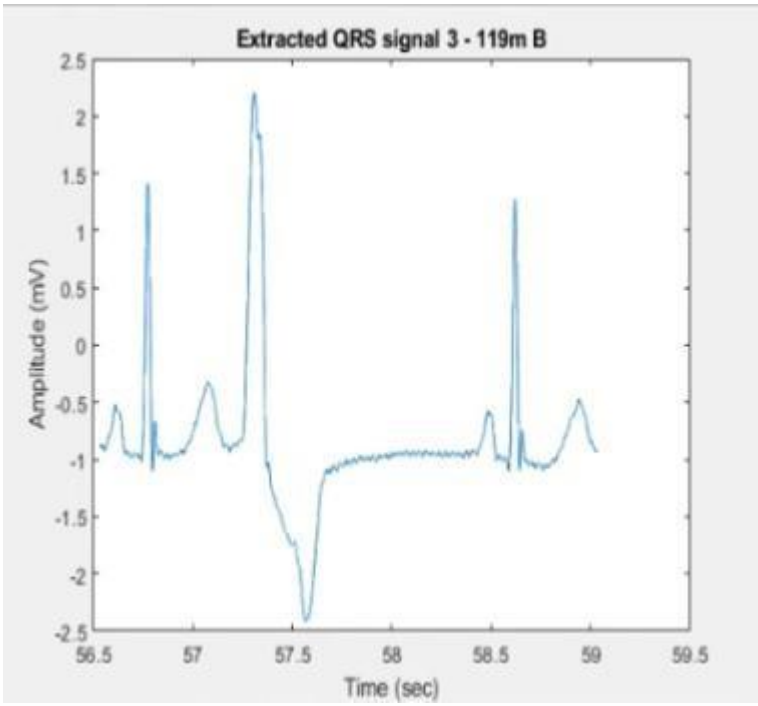

Fig. 5. Configuration of multiclass signal 3

Using the proposed approach, we have developed a Multiclass Artificial Neural Network from scratch to predict and envisage the presence of cardiovascular disease in patients.

5 Results and discussion

The in-depth study was promised to integrate clinical information better, dress code inconsistently inpatient types of disease, bridge the opportunity to omit research and bed phenotypes and beyond special availability of pharmaceuticals. Advances in science may be required to overcome existing limitations, including limiting ideas. Based on the design and modeling, characteristic definition limits, approaches to overcome overfitting, cardiovascular, specifically, is considered to be fit to benefit from the research expertise currently existing in the literature. It is because it saves data streams from combining regular health records along with lifestyle instructions. If the information privacy and data security concerns are content, this combination can build the foundation of a "medical Internet of Things (IoT)" improving the incorporation of different bases of the data allowing continuous monitoring and observance of diseases, risk factors, and early warnings of possible damage (Anon., 2020)

In the meantime, creative outcome of DL are available yet there is a need to get positive results, and many challenges have to be addressed. Firstly, DL is deployed as the inexplicable black box in the hospitals as an inexplicable black box. Many methods allow 'approach-agnostic' scales for interpreting characteristics of experimental studies. Thus, doubtless, insights into Human Cognition may eventually yield intuitions to explain deep learning metaphors. Secondly, all of

the ML algorithm are more likely to suffer from overfitting if the data is restricted and/or algorithms are complicated. In some models, DL algorithm provides comparable results to statistical regression (e.g., logistic regression), and it means that different benefits are more relevant in various types of information. In future, further studies may combine deep learning algorithms with well-defined classifications.

6 Conclusion

Studies may not only reveal hidden information in complex data, but may also provide solution to analyze and evaluate some diseases with the use of DL algorithms as a pathway between diseases, that enable specific, However, to change the care of the heart, DL algorithms need to be programmed logically to improve defined vigorously, and ~~in~~ experimental development methods for authentication and testing. The deep learning is considered to be the most interesting algorithm through which better results can be obtained and improvement in models is possible eventually. It isn't always necessarily the first-class set of rules, and its overall performance limit needs to be fairly evaluated. There are often robust solutions to most human imaging troubles, for which artificial intelligence holds a promising task. Whether it is practicable or not, it relies on the facts of predication regarding gaining knowledge. The existing literature on DL in the area of scientific imaging module uses evaluation of medical knowledge with a purpose to be integrated into clinical exercise. In this paper, we have reviewed all the basic modules of ML algorithms and possible sources of information about medicines assessing the need for DL in medicine, evaluated the limited strengths of the challenges, and challenges in implementing DL in medicine. In Future, more information can be extracted using different algorithms in productive manner in the domain of bio-medicine, pharmaceutical management, and its applications.

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