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# Understanding the Impact of Deep Learning Algorithms on Healthcare Diagnostics

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**ABSTRACT:** To develop a scalable, deep-learning approach that exceeds state-of-the-art ADR detection performance in social media. We developed a recurrent neural network (RNN) model that labels words in an input sequence with ADR membership tags. The only input features are word-embedding vectors, which can be formed through task-independent pretraining or during ADR detection training. In particular, Deep Learning (DL) techniques have been shown as promising methods in pattern recognition in the healthcare systems. Motivated by this consideration, the contribution of this paper is to investigate the deep learning approaches applied to healthcare systems by reviewing the cutting-edge network architectures, applications, and industrial trends. The goal is first to provide extensive insight into the application of deep learning models in healthcare solutions to bridge deep learning techniques and human healthcare interpretability. Neither the reviewers nor the citing authors raised similar concerns. The integration of DL with medical image analysis enables real-time analysis of vast and intricate datasets, yielding insights that significantly enhance healthcare outcomes and operational efficiency in the industry. This extensive review of existing literature conducts a thorough examination of the most recent deep learning (DL) approaches designed to address the difficulties faced in medical healthcare, particularly focusing on the use of deep learning algorithms in medical image analysis.

**KEYWORDS:** deep-learning, Healthcare Diagnostics, deep-learning architecture, medical healthcare, and electronic health records (EHRs).

## I. INTRODUCTION

Health care is coming to a new era where the abundant biomedical data are playing more and more important roles. In this context, for example, precision medicine attempts to 'ensure that the right treatment is delivered to the right patient at the right time' by taking into account several aspects of patient's data, including variability in molecular traits, environment, electronic health records (EHRs) and lifestyle. Machine learning is a general-purpose method of artificial intelligence that can learn relationships from the data without the need to define them a priori. The major appeal is the ability to derive predictive models without a need for strong assumptions about the underlying mechanisms, which are usually unknown or insufficiently defined. For decades, constructing a machine learning system required careful engineering and domain expertise to transform the raw data into a suitable internal representation from which the learning subsystem, often a classifier, could detect patterns in the data set. Conventional techniques are composed of a single, often linear, transformation of the input space and are limited in their ability to process natural data in their raw form. Deep learning is different from traditional machine learning in how representations are learned from the raw data. In fact, deep learning allows computational models that are composed of multiple processing layers based on neural networks to learn representations of data with multiple levels of abstraction. The major differences between deep learning and traditional artificial neural networks (ANNs) are the number of hidden layers, their connections and the capability to learn meaningful abstractions of the inputs.

## II. LITERATURE REVIEW

**Christopher J. Kelly (2019)** Artificial intelligence (AI) research in healthcare is accelerating rapidly, with potential applications being demonstrated across various domains of medicine. However, there are currently limited examples of such techniques being successfully deployed into clinical practice. This article explores the main challenges and limitations of AI in healthcare, and considers the steps required to translate these potentially transformative technologies from research to clinical practice. The safe and timely translation of AI research into clinically validated and appropriately regulated systems that can benefit everyone is challenging. Robust clinical evaluation, using metrics that are intuitive to clinicians and ideally go beyond measures of technical accuracy to include quality of care and patient outcomes, is essential.

**Radoslaw Wrobel (2019)** This study discusses the use of wavelet decomposition in the diagnostics of vibrometric signals of an engine. Apart from presenting the possibility of using wavelets in diagnostics, the authors take up the

subject of the applicability range of processing for stationary signals, which until now has been reserved for non-stationary signals. A unified definition of signal stationarity has been proposed, which is not based on statistics. Laser measurements allow for studying an object without “touching” its housing. Basing on the relative velocity of engine vibrations, the authors indicate how reliable vibrations are in diagnostics. Despite higher costs, this measurement method gives better results (for specific cases) than acoustic studies. Transform-wavelet decomposition is a solution hardly ever used in machine diagnostics; it is more often applied in medicine and image recognition.

**Shuang Wang (2018)** Gaining knowledge and actionable insights from complex, high-dimensional and heterogeneous biomedical data remains a key challenge in transforming health care. Various types of data have been emerging in modern biomedical research, including electronic health records, imaging, -omics, sensor data and text, which are complex, heterogeneous, poorly annotated and generally unstructured. The latest advances in deep learning technologies provide new effective paradigms to obtain end-to-end learning models from complex data. In this article, we review the recent literature on applying deep learning technologies to advance the health care domain. Based on the analyzed work, we suggest that deep learning approaches could be the vehicle for translating big biomedical data into improved human health. However, we also note limitations and needs for improved methods development and applications, especially in terms of ease-of-understanding for domain experts and citizen scientists.

**Tayseer Alkhazali (2017)** The present study aimed to investigate the effect of designing a blended learning environment on achievement and deep learning of the Arabian Gulf university students in a design and presentation of instructional materials' graduate course. A blended learning environment was designed to provide opportunity for integrating the learning management system “moodle” with face-to-face classroom interaction. To explore the extent to which students learnt the course content, an achievement test was used. A deep learning scale was also used to investigate the depth of learning acquired by students who studied the course content through the blended learning environment. Results of the study showed that students' scores on the post application of the achievement test were improved.

**Angus McCoss (2016)** An original quantum foundations concept of a deep learning computational Universe is introduced. The fundamental information of the Universe (or Triuniverse) is postulated to evolve about itself in a Red, Green and Blue (RGB) tricoloured stable self-mutuality in three information processing loops. From its substrate of Mathematics, the knotted information processing loops determine emergent Physics and thence the evolution of super-emergent Life (biological and artificial intelligence). In Physics, the trefoil macrocycle is Quantum Intelligent Geometrodynamics and its correlation system is Quantum Darwinism. Super-emergent Life has corresponding RGB-tricoloured loops of Variation (R), Selection (G) and Heredity (B). In the evolution of Life, the trefoil macrocycle is Variational Selective Heredity and its correlation ecosystem is Darwin's ecologically “Entangled Bank”.

### Deep learning

Deep learning is the subset of machine learning methods based on neural networks with representation learning. The adjective “deep” refers to the use of multiple layers in the network. Methods used can be supervised, semi-supervised or unsupervised. Deep-learning architectures such as deep neural networks, deep belief networks, recurrent neural networks, convolutional neural networks and transformers have been applied to fields including computer vision, speech recognition, natural language processing, machine translation, bioinformatics, drug design, medical image analysis, climate science, material inspection and board game programs, where they have produced results comparable to and in some cases surpassing human expert performance.

### Deep Learning In A Nutshell

Deep learning, also known as hierarchical learning or deep structured learning, is a type of machine learning that uses a layered algorithmic architecture to analyze data. In deep learning models, data is filtered through a cascade of multiple layers, with each successive layer using the output from the previous one to inform its results. Deep learning models can become more and more accurate as they process more data, essentially learning from previous results to refine their ability to make correlations and connections. Deep learning is loosely based on the way biological neurons connect with one another to process information in the brains of animals. Similar to the way electrical signals travel across the cells of living creates, each subsequent layer of nodes is activated when it receives stimuli from its neighboring neurons. In artificial neural networks (ANNs), the basis for deep learning models, each layer may be assigned a specific portion of a transformation task, and data might traverse the layers multiple times to refine and optimize the ultimate output.

### Convolutional neural network

Convolutional Neural Network (CNN) is a supervised deep learning architecture. It is mainly used for image analysis applications. CNN includes three types of layers namely, convolutional layers, pooling layers, and fully connected layers. In the convolutional layer, the input image passes through kernels or filters to generate some feature maps. In the pooling layer, the size of each of the feature maps is reduced to keep the number of weights small. This process is also known as down sampling or subsampling. There exist various kinds of pooling methods such as global pooling,

max pooling, and average pooling. After these aforementioned layers, the fully connected layer is used to transform two-dimensional feature maps into a one-dimensional vector for final classification.

#### Health care

Health care, or healthcare, is the improvement of health via the prevention, diagnosis, treatment, amelioration or cure of disease, illness, injury, and other physical and mental impairments in people. Health care is delivered by health professionals and allied health fields. Medicine, dentistry, pharmacy, midwifery, nursing, optometry, audiology, psychology, occupational therapy, physical therapy, athletic training, and other health professions all constitute health care. The term includes work done in providing primary care, secondary care, and tertiary care, as well as in public health. Access to healthcare may vary across countries, communities, and individuals, influenced by social and economic conditions as well as health policies. Providing health care services means "the timely use of personal health services to achieve the best possible health outcomes".

#### The challenges of deep learning

As deep learning is a relatively new technology, certain challenges come with its practical implementation.

**Large quantities of high-quality data:** Deep learning algorithms give better results when you train them on large amounts of high-quality data. Outliers or mistakes in your input dataset can significantly affect the deep learning process. For instance, in our animal image example, the deep learning model might classify an airplane as a turtle if non-animal images were accidentally introduced in the dataset.

To avoid such inaccuracies, you must clean and process large amounts of data before you can train deep learning models. The input data preprocessing requires large amounts of data storage capacity.

**Large processing power:** Deep learning algorithms are compute-intensive and require infrastructure with sufficient compute capacity to properly function. Otherwise, they take a long time to process results.

#### Relation to human cognitive and brain development

Deep learning is closely related to a class of theories of brain development (specifically, neocortical development) proposed by cognitive neuroscientists in the early 1990s. These developmental theories were instantiated in computational models, making them predecessors of deep learning systems. These developmental models share the property that various proposed learning dynamics in the brain (e.g., a wave of nerve growth factor) support the self-organization somewhat analogous to the neural networks utilized in deep learning models. Like the neocortex, neural networks employ a hierarchy of layered filters in which each layer considers information from a prior layer (or the operating environment), and then passes its output (and possibly the original input), to other layers. This process yields a self-organizing stack of transducers, well-tuned to their operating environment.

### III. RESEARCH METHODOLOGY

The new architecture of CNN is proposed along with the optimization technologies such as PSO. In the presented framework for ECG signal classification, Wavelet feature extraction and classifiers - Support Vector Machine (SVM), Artificial Neural Network (ANN), Convolution Neural Networks (CNNs) are compared with the proposed PSO optimized CNN based approach for ECG classification. Support Vector Machine (SVM) is a popular classifier in the supervised learning algorithms. Initially the ECG dataset which is acquired from the MIT-BIH database was tested with SVM for checking the accuracy levels. Once the optimized CNN architecture is ready, the data collected from IoT gateway is used to evaluate the performance. For collecting the data without any packet loss in the network the optimized REL protocols are applied. A Discrete Wavelet Transform (DWT) will be efficient in making an analysis of the adaptive time-frequency decomposition. Using a representation of a multi-resolution, only a few coefficients within the wavelet domain will be required to describe the structure of the signal. To analyze the signal using the WT, a choice of suitable wavelets, and levels of decomposition were found to be crucial. The wavelet transform can be employed in denoising, signal preprocessing, and extracting transform coefficients in the form of features for classifier inputs. Momentum learning can be used to improve the gradient descent to ensure the memory term was used to increase the speed and establish stability in convergence.

### IV. RESULTS AND DISCUSSIONS

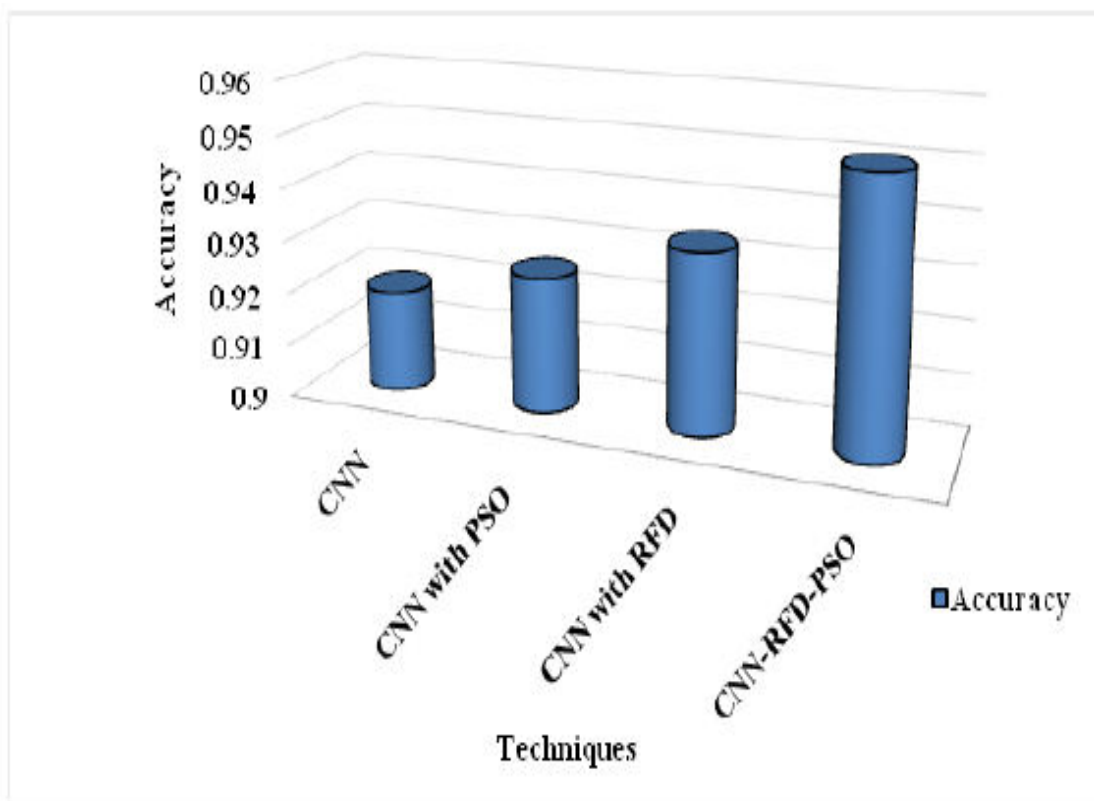
In this section CNN with PSO, CNN with RFD and CNN with RFD-PSO methods are evaluated. MIT-BIH Arrhythmia dataset has been utilized in different research works for the classification and detection of arrhythmia. MIT-BIH Arrhythmia Database was compiled from the collection of ECG recordings from 47 subjects (25 men and 22 women) with an age range between 23 years to 89 years for a 24-hour period.



**Table 1: Accuracy for CNN-RFD-PSO**

	Accuracy
CNN	91.92%
CNN with PSO	92.55%
CNN with RFD	93.37%
CNN-RFD-PSO	95.05%

The ECG classification for accuracy, sensitivity, specificity, and f measure is shown in this section. From Table 1 we can able to find out the improvements in accuracy levels of CNN-RFD-PSO. The traditional CNN gives 91%, whereas the hybrid approach CNN-RFD-PSO gives 95% of accuracy in classifying the arrhythmia types. For 20 iterations PSO takes 2.3 seconds, RFD takes 2.1 seconds to react. The hybrid approach CNN-RFD-PSO gives the results in 1.8 seconds.



**Graph 1: Accuracy of CNN-RFD-PSO**

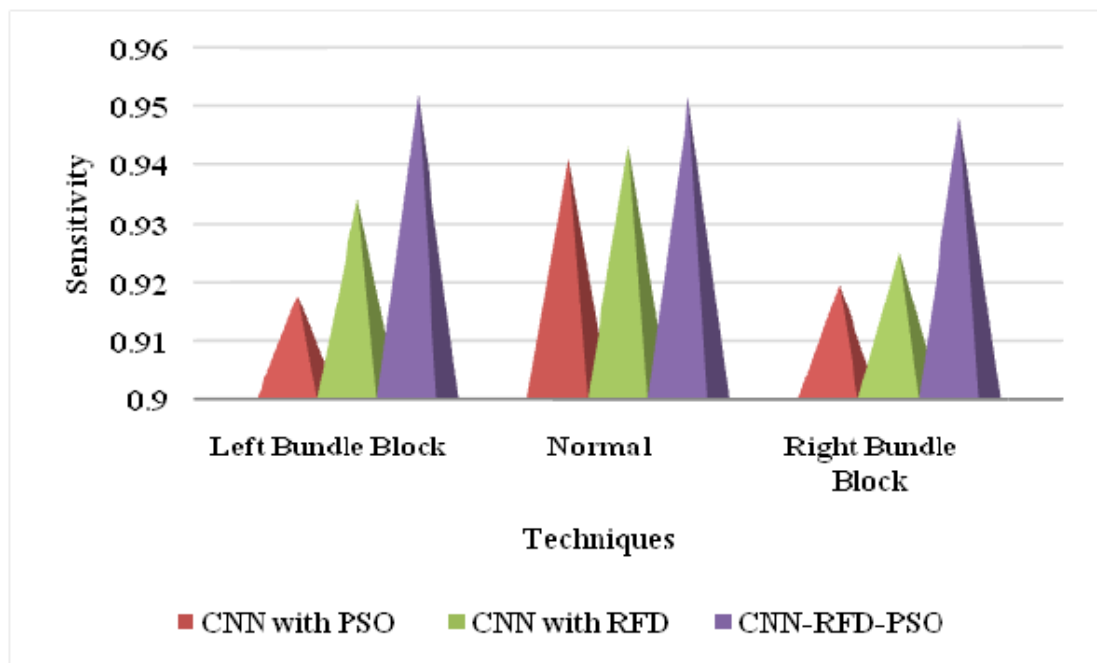
From Graph 1, it can be seen that the CNN-RFD-PSO has higher accuracy by 3.35% for CNN, by 2.66% for CNN with PSO and by 1.78% for CNN with RFD, respectively.



**Table 2: Comparisons of performance metrics for CNN-PSO, CNN-RFD and CNN-RFD-PSO**

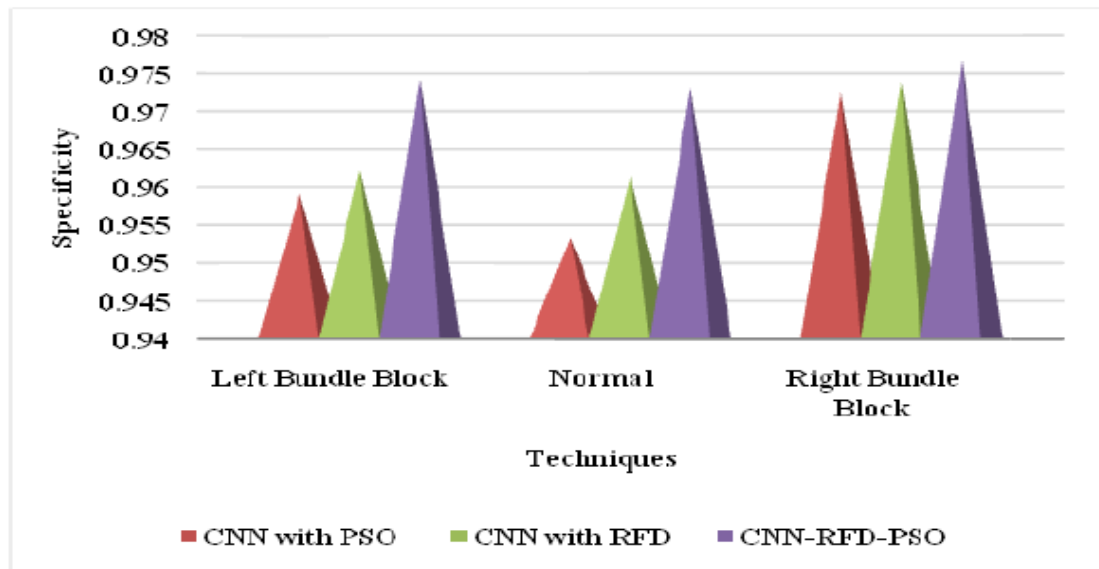
Performance Measures	Sensitivity			Specificity			F1-Score		
	Classes								
Techniques	LBBB	RBBB	Normal	LBBB	RBBB	Normal	LBBB	RBBB	Normal
CNN-PSO	91.78	91.96	94.1	95.92	97.24	95.33	91.92	93.54	92.11
CNN-RFD	93.43	92.5	94.33	96.22	97.39	96.15	93.08	93.93	93.03
CNN-RFD-PSO	95.21	94.81	95.15	97.43	97.67	97.3	95.1	95.37	94.62

River formation Dynamics is the emerging technique in the field of optimization nowadays. Though it has less research studies of this methodology, this is yet another upcoming technology which gives best optimized results. As mentioned earlier this algorithms follows a nature’s phenomenon of how waters form a river and a river in to sea based on the altitude change. The water drops used to move from a high altitude value to the low altitude values by eroding the paths.



**Graph 2: Sensitivity of CNN-RFD-PSO**

The water drops used to move from a high altitude value to the low altitude values by eroding the paths. This process continues for all the nodes until it finds a shortest path. When a new node comes to the network, it is placed in the origin and the shortest path is recommended by the system based the history of the erosion. If a particular node finds no other way after such situations, the node will evaporate and disappear from the process. Thus the shortest path is determined.

**Graph 3: Specificity for CNN-RFD-PSO**

From Graph 3, it can be seen that the CNN-RFD-PSO has higher specificity by 2.1%, 1.56% & 1.25% for L beats, by 5.38%, 2.04% & 1.18% for N beats, and by 0.29%, 0.44% & 0.28% for R beats when compared with CNN with PSO and CNN with RFD respectively.

#### IV. CONCLUSION

The deep learning models are categorized according to supervised and unsupervised learning techniques. Due to these algorithms' significant importance, medical devices should be built over time using DL models, such as the microscope, phonendoscope, and electrocardiogram, to accommodate physicians' perceptive capability limitations. In processing and forecasting answers from large datasets, deep learning is playing a critical role. Scientists expect advancement in the prediction of personalized drug response, optimization of medication selection and dosage, and an application of genetic modification to provide treatment for genetic disorders and mutations. Although some models, such as CNN and RNN-GRU, provide outcomes that are either flawless or above 100% accuracy, there are overall signs that the future of deep learning (DL) in healthcare is bright. Reliable and clinically significant findings need careful consideration of biases, overfitting, and hyper parameter nuances, as demonstrated by the figures that illustrate the complex outcomes across various DL setups. With its application, ML can augment the role of physicians and redefine patient care. Concluding all, research on deep learning models in healthcare is extensive, and still, many challenges are laid forward. Designing these healthcare systems methods is a significant challenge that can improve the processing system to build more effective and efficient devices.

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