Fusion Optimization and Classification Model for Blockchain Assisted Healthcare Environment

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Abstract

Healthcare transformation is becoming one of the highest priorities in a world whereby remarkable advances in technology are taking place. Recent healthcare data fusion management systems are centralized, which possess the probability of failure in case of a natural disaster. Blockchain has expanded fast to be the most widely spoken innovation that could address a large number of present data management problems in the health care sector. The usage of blockchain technology for the distribution of secure and safe health care datasets has received all the attention. This article presents a Bat Optimization Algorithm with Fuzzy Neural Network Based Classification (BOA-FNNC) Model for Blockchain Assisted Healthcare Data Fusion Environment. The presented BOA-FNNC technique mainly focuses on achieving security in the healthcare sector using BC technology. For accomplishing this, the BOA-FNNC technique performs BC assisted data transmission in the medical sector. Besides, the VGG-16 model is exploited for the creation of feature vectors. To classify healthcare data, the BOA with FNN model is utilized in this study, where the BOA fine tune the parameters related to the FNN model which in turn boosts the classifier efficiency. For illustrating the betterment of the BOA-FNNC technique, a series of experiments were performed. The comparison study reported the enhancements of the BOA-FNNC technique over other recent approaches.

Keywords: Blockchain; Healthcare; Fusion Optimization; Fuzzy neural network; Bat algorithm; Security; Classification

1. Introduction

The health informatics method of budgeting patients, lawful questions, logistics, supplies, and different methodology and medical work processes are frequently comprised of a succession of restrictive advances that can be pictured as a progression of rehashed patient-care exercises [1]. Among emergency clinics and other healthcare specialist organizations, inner controls ought to be expanded; execution, and consistency ought to be upgraded; and risk, work time, and above ought to be diminished [2]. This study frames a healthcare savvy contract structure that deals with patient information and works on confounded medical therapies, in light of cutting-edge healthcare Blockchain (BC) examination and a hearty way to deal with healthcare the executives [3]. We have seen cutting-edge BC concentrates on in healthcare and introduced a BC-related answer for healthcare executives. As demonstrated by various efforts in different nations and economies, states and related business areas are turning out to be more engaged with digitalizing healthcare frameworks [4]. The way to progress is to coordinate innovation into each organization's DNA by using AI, BC, and some open advancements. To propel healthcare research and accomplish patient-centricity, the business would utilize innovation to make client and client driven connection points and information driven choices for imaginative

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information handling approaches and improved results [5]. For instance, man-made reasoning (AI) can aid distinguish and focus on patients for drug checking and development, basic for overseeing drug creation, and more limited courses of events. For reusing showcased meds, researching the viability of medical definitions, and portion estimation, clinical preliminary information was observed utilizing mathematical medication plan techniques and AI [6]. As a result of such a quickly developing environment, states should distinguish the best ways of utilizing assets and drive change while guaranteeing the essential consistency, or information security. BC supports the making of a framework that creates and oversees content blocks termed ledgers, with protected and computerized information examination. All wellbeing related information is securely recorded and broken down, permitting medical specialists, healthcare suppliers, and payers to get opportune updates [7]. This can be made a stride further by AI calculations to the BC. To understand well-being patterns and examples, AI started to think and study like a physician. It accumulates data from different sources, which invokes the patient, the radiotherapist, and pictures as unstructured information.

To share information freely among medical subject matter experts, clinical staff, patients, and different partners, it requires a defended infrastructure. EMRs are profoundly delicate information, and as we store this information over the internet, higher is the weakness toward its undesirable exposure [8]. The health care frameworks being used today use a brought together design requesting bound together trust over a quick and solid correspondence medium. A productive alliance of EMR and interoperability amid the present frameworks that continues as a challenging activity. Also, the patients have restricted to no guidelines over their information. To make the framework computerized and make it simple to utilize, AI-helped procedures like OCR can be useful [9]. In light of the previously mentioned weaknesses, there is a requirement for a framework wherein controls are user centric, and the protection of the clients and the information are safely kept up with. Medication, determination, and treatment processes are found to include BC innovation, which can dramatically aftereffect extra worth [10]. BC innovation has risen out of bitcoin and relaxations over public key infrastructure (PKI) and pseudo-anonymity by supervising the secrecy of its end client, viz, patients in the important situation.

The BC is a disseminated data set utilizing state machine replication, with nuclear changes to the information base alluded to as exchanges gathered into blocks, with uprightness and altered opposition of the exchange log guaranteed through hash joins amid blocks. The BC idea was presented for Bitcoin with regards to de-centralized electronic money. The notoriety of Bitcoin permits BC that can use without contingent upon any settled outsider to empower dependable and safe exchanges via untrustworthy networks. There were several reports on essential structure blocks in the BC. A consecutive sequence of blocks has a rundown of complete and address exchange records is BC. The blocks are associated by a connection (hash worth) to the past block, consequently making a chain. The block that goes before a given block is perceived as its block header, and the absolute first block was perceived as the block of beginning. With a developing revenue in numerous applications, spreading over from information capacity, monetary business sectors, PC security, IoT, and dietary science to the healthcare area and cerebrum researchers, BC innovation has acquired enormous fame and advanced to disseminate protected and stable observing of healthcare records. It could be a device later on that could hypothetically aid tweaked, trustworthy, and safe healthcare by joining and showing the entire constant clinical records of a patient's prosperity in a cutting-edge, secure healthcare arrangement.

Bhattacharya et al. [11] modelled a structure named BC-related DL as-a-Service (BinDaaS). It compiles BC and DL approaches to share the EHR records amongst many healthcare users and functions in 2 stages. An authentication and signature method can be suggested in the first stage depending on lattices-related cryptography for resisting collusion assaults amongst N-1 health care specialists from N. In the next stage, DL as-a-Service (DaaS) can be utilized on stored EHR data sets for predicting future ailments grounded on patients' current indicators and characteristics. In [12], BC-enabled secure data management framework (BSDMF) was recommended for health data depends on the IoMT to strongly interchange patient data and enrich scalabilities and data accessibilities health care atmosphere. The devised BSDMF offers safe data management among implantable medical devices and personal servers and personal-and-cloud servers. Lakhan et al. [13] examined scheduling and offloading perplexities for health care tasks in IoMT fog-cloud net. Thus, the work regarded the issue as scheduling and offloading perplexity and framed DRL as Markov problem. This working model is the new DRL and BC-assisted

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mechanism and has multi-criteria offloading related to DRL procedures and BC task scheduling (TS) with task sequencing and research matching approach for healthcare workloads in the IoMT mechanism.

Alqaralleh et al. [14] project DL with BC-enabled secure image transmission and prognosis method for the IoMT atmosphere. The proposed method has certain processes such as hash value encryption, data collection, data classification, and secure transaction. Mainly, elliptic curve cryptography (ECC) can be implied, and the optimal key generating ECC is done utilizing hybrid grasshopper with fruit fly optimization (GO-FFO) technique. In conclusion, a deep belief network (DBN) can be used to classify the diagnosis process. Al-Qarafi et al. [15] advance an Optimal ML -related Intrusion Detection System (IDS) for Privacy Preserving BIoT together with Smart Cities Atmosphere, termed OMLIDS-PBIoT method. The existing OMLIDS-PBIoT approach feats ML and BC approaches for accomplishing security in the smart city setting. To achieve this, the devised OMLIDS-PBIoT algorithm uses data pre-processing at the beginning level for transforming the data into a compatible form. Also, a golden eagle optimization (GEO)-related feature selection (FS) method can be devised for deriving valuable feature sub-sets.

This article presents a Bat Optimization Algorithm with Fuzzy Neural Network Based Classification (BOA-FNNC) Model for BC Assisted Healthcare Data Fusion Environment. The presented BOA-FNNC technique mainly focuses on achieving security in the healthcare sector using the BC technology. For accomplishing this, the BOA-FNNC technique performs BC assisted data transmission in the medical sector. Besides, the VGG-16 model is exploited for the creation of feature vectors. To classify healthcare data, the BOA with FNN model is utilized in this study, where the BOA fine tune the parameters related to the FNN model which in turn boosts the classifier efficiency. For illustrating the betterment of the BOA-FNNC technique, a series of experiments were performed.

2. The Proposed BOA-FNNC Model

This article has introduced a BOA-FNNC Model for Blockchain Assisted Healthcare Data Fusion Environment. The presented BOA-FNNC technique mainly focuses on achieving security in the healthcare sector using BC technology.

2.1 BC based Data Fusion Transmission

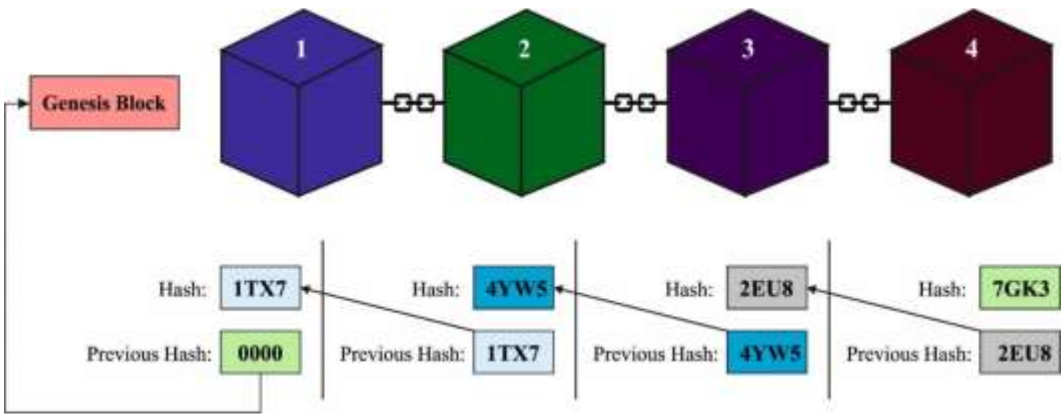

Figure 1: Architecture of Blockchain

The BOA-FNNC technique performs BC assisted data fusion transmission in the medical sector. The BC is a collection of blocks, whereby each block is made up of timestamp, transaction details (bitcoin, Ethereum), hash value of current block, and existing block [16]. BC is a public, decentralized, and shared digital ledger used to store the transaction in various modes. Therefore, an intruder record could not adapt since every block is made up of the cryptographic values of the present block. In the BC mechanism, every transaction is signed cryptographically over hash values and authenticated through

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the miners. It encompasses repetitive measures of ledger and block of each transaction. BC presents the ability to allocate the data ledger in trusted, decentralized, shared, and safe method. Fig. 1 depicts the framework of BC. Decentralized storage is a kind of BC and is used to save maximal information that is interconnected to current and previous blocks through smart contract code. The Interplanetary File System (IPFS) is determined by the shared, Point to Point, and decentralized dataset that is connected and forward standard file. IPFS is significantly stored that is exploited through a BC method for IoT function to obtain maximal throughput.

2.2 VGG-16 Feature Extractor

Next, the VGG-16 model is exploited for the creation of feature vectors. DNN are methods that capture hierarchical representation of information. These techniques are dependent upon the sequential application of computation "element", whereas the results of preceding element are the input to next one; these elements are named layers. All the layers offer one presentation level. The layer was parameterized through a group of weighted linking input to output units and a group of biases. In CNN, weights were locally shared, viz., the similar weights were executed at all the places of inputs. The weight is linked to similar output unit procedures filters.

VGG-16 is a well-known convolution network. It was established by the visual geometry group that is called VGG-16. Rather than having several hyperparameters, VGG16 focuses on having convolution layer of 33 filters with stride 1 and employs the similar padding and max pooling layers of 22 filters of stride 2 [17]. Eventually, it comprises two $softmax$ and FC layers for the output. The 16 in VGG16 signifies the 16 layers that have weight. VGG16 has around 138 million parameters hence it is a larger network. VGG is a pretrained form of the network trained on over a billion images from the ImageNet data. It classifies images into thousands of object classes that lead to the network learning on rich feature representations for different images. The input size of an image in VGG16 is 224 224.

2.3 FNN based Classification

To classify healthcare data, the FNN model is utilized in this study. Here, the FNN is employed for classifying the medical flow beforehand the attribution of lost medical flow dataset [18]. Fig. 2 demonstrates the infrastructure of FNN. The particular step is given below:

Step 1: utilize the FNN for training the medical dataset and attain the enhanced value of parameters: m, b, and w. The m variable is the centralized value of membership function of additional layer. The b parameter indicates the width of membership function of the subsequent layer. The w variable is the connectivity weights of input layer;

Step 2: utilize the regulated FNN to complete classifier method as follows:

Layer 1: input an Eigen-vector that involves 5 attributed values of a time namely $V_i = \{a_l(x_i)$, $a_2(x_i)$, $a_3(x_i)$, $a_4(x_i)$, $a_5(x_i)\}$;

Layer 2: (blur layer): determine the member function. Gaussian function is applied by the member function for the generality:

$$\mu j_i = \lambda \frac{(v_i - m_{ij})^2}{b_{ij^2}} \tag{1}$$

In Eq. (1), v_i shows medical flow dataset, and j indicates the member function set.

Layer 3 (rule antecedent layer): utilize the MAMDANI reasoning methodology:

$$\mu_A(\overline{v}) = \underset{i=1}{\overset{n}{T}} \mu_{A_j}(\overline{v})i \tag{2}$$

In Eq. (2) $A = A_1 \times A_2 \times \ldots \times A_n$, n indicates the amount of input attribute and is fixed as 5. A_n refers to the member function of n attribute, and T denotes t-norm.

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Layer 4: Evaluate the membership of object x:

$$\bar{z} = \sum_{r=1}^{n} \bar{p}^r \, \mu_{A^r}(\bar{v}) \tag{3}$$

$$p^r = \frac{w^r}{\sum w^r} \tag{4}$$

Layer 5: set classifier range based on the outcome of the fourth layer and generate the data sample falls in the similar range to the similar group.

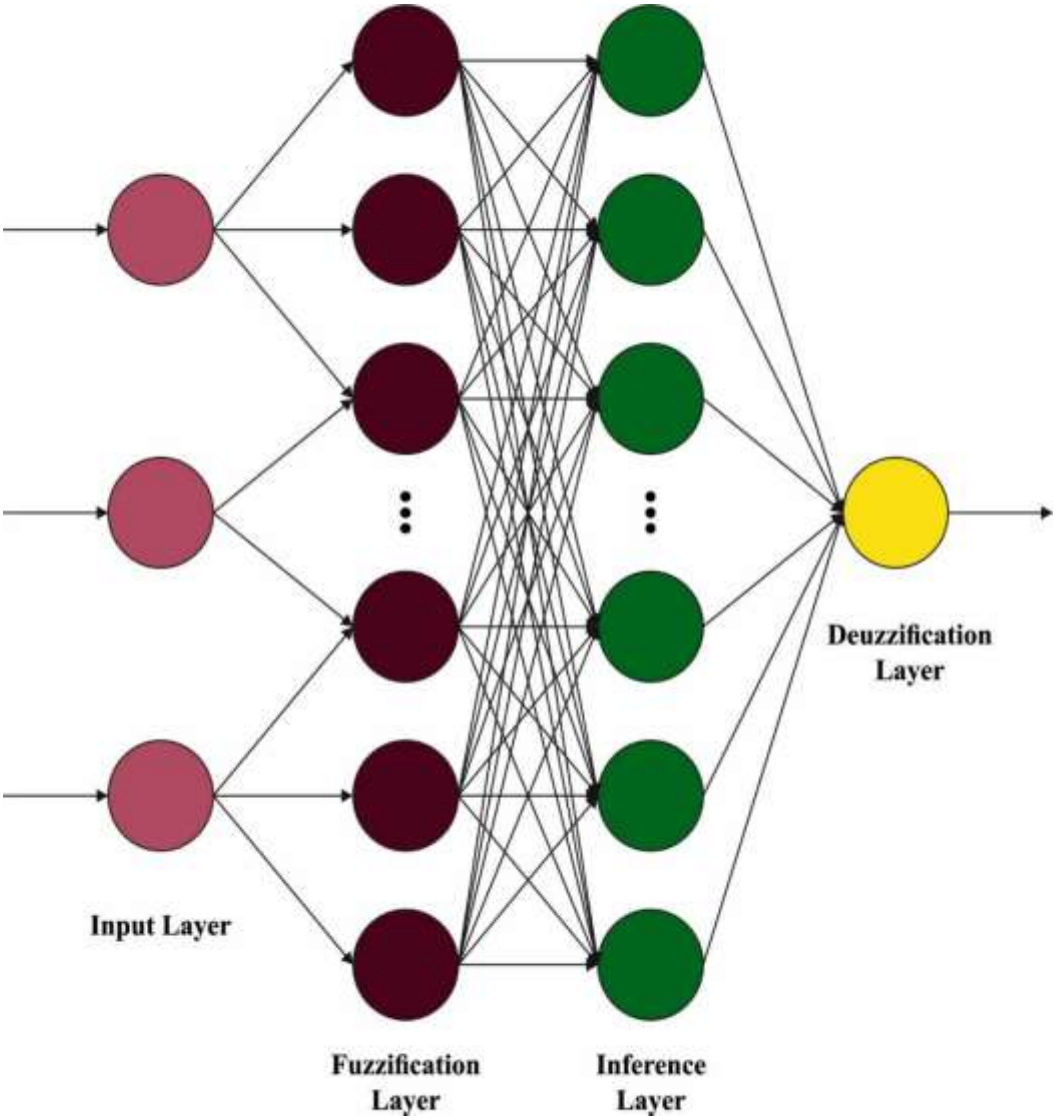

Figure 2: Structure of FNN

Step 3: the dataset is classified into different classes by executing the step from 1 to 2, and evaluate the value of lost dataset through the hybrid mechanism.

2.4 Parameter Tuning using BOA

In this work, the BOA fine tune the parameters related to the FNN model which in turn boosts the classifier efficiency. BOA is an optimization procedure for global optimization [19]. This procedure simulates the behavior of bats. Once the bat finds and seeks the prey, the loudness, frequency, and

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pulsation rate (r) are transformed. The frequency, position, and velocity of bats are upgraded in the following:

$$f_l = f_{min} + (f_{max} - f_{min})\beta \tag{5}$$

$$y_l(t) = y_l(t-1) + v_l(t), t = 1, \dots, T \tag{6}$$

$$v_l(t) = [y_l(t-1) - Y*] \times f_l, t = 1, \dots, T \tag{7}$$

From the expression, f_m denotes the minimal frequency, $fmax$ denotes the maximal frequency, β shows the arbitrary value, yl(t) shows the location at time step (t), $Y*$ represent the optimal solution, T denotes the overall period of assessment and fl indicates the frequency. After choosing a solution from amongst the optimal present solutions, a novel solution for every bat is locally derivative as follows:

$$y(t) = y(t+1) + \varepsilon A(t), t = 1, 2, \dots, T \tag{8}$$

Now, $A(t)$ denotes the average loudness and ε represents the random value. The pulsation rate rises once a bat explores the prey, whereas the loudness reduces. The pulsation rate and loudness values are upgraded by the following equation:

$$r_l^{t+1} = r_l^0[1 - \exp(-\gamma t)]A_l^{t+1} = \alpha A_l^t \tag{9}$$

Now γ and α denote the constant value.

3. Experimental Validation

The performance validation of the BOA-FNNC model is tested using a set of dermoscopic skin lesion images. Fig. 3 depicts sample test images.

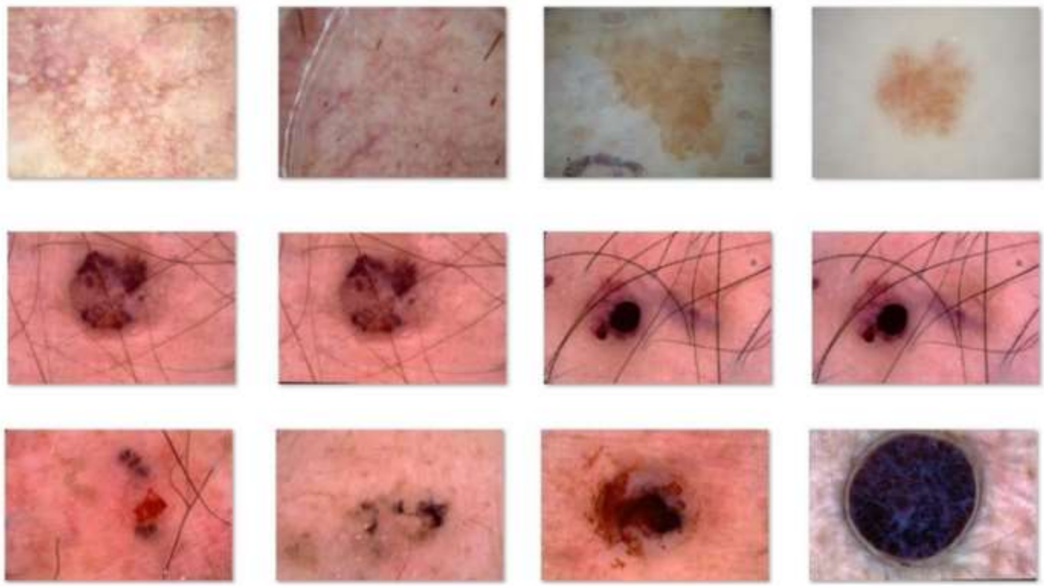

Figure 3: Sample images

Table 1 demonstrates the overall results offered by the BOA-FNNC model on distinct runs and classes. On run-1, the BOA-FNNC model has classified ANG with $sens_y$, $spec_y$, $accu_y$, and $F_{measure}$ of 0.8543, 0.8476, 0.848, and 0.8088 respectively. At the same time, the BOA-FNNC approach has classified NEV with $sens_y$, $spec_y$, $accu_y$, and $F_{measure}$ of 0.8326, 0.8469, 0.8449and 0.822 correspondingly. Finally, the BOA-FNNC method has classified LNOS with $sens_y$, $spec_y$, $accu_y$, and $F_{measure}$ of 0.8299, 0.8507, 0.848, and 0.8299 correspondingly. , Meantime, the BOA-FNNC approach has classified SLG with $sens_y$, $spec_y$, $accu_y$, and $F_{measure}$ of 0.8249, 0.8503, 0.8449, and 0.8321 correspondingly. Parallelly, the BOA-FNNC approach has classified MEL with $sens_y$, $spec_y$, $accu_y$,

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and $F_{measure}$ of 0.8347, 0.8468, 0.8449, and 0.8252 respectively. In Addition, the BOA-FNNC technique has classified SKT with $sens_y$, $spec_y$, $accu_y$, and $F_{measure}$ of 0.8173, 0.8505, 0.8449, and 0.8263 correspondingly.

Table 1: Result analysis of BOA-FNNC approach with distinct measures and runs

Classes	Sensitivity	Specificity	Accuracy	F-Measure
Run-1				
ANG	0.8543	0.8476	0.848	0.8088
NEV	0.8326	0.8469	0.8449	0.822
LNOS	0.8299	0.8507	0.848	0.8299
SLG	0.8249	0.8503	0.8449	0.8321
MEL	0.8347	0.8468	0.8449	0.8252
SKT	0.8173	0.8505	0.8449	0.8263
BCC	0.8002	0.8543	0.848	0.8265
Run-2				
ANG	0.8543	0.8543	0.8543	0.8543
NEV	0.8326	0.8469	0.8449	0.822
LNOS	0.8055	0.8507	0.8449	0.8173
SLG	0.8249	0.8423	0.8386	0.8178
MEL	0.8347	0.8506	0.848	0.8347
SKT	0.8173	0.8467	0.8417	0.8173
BCC	0.8002	0.8507	0.8449	0.8132
Run-3				
ANG	0.8543	0.8543	0.8543	0.8543
NEV	0.8326	0.8543	0.8512	0.8433
LNOS	0.8055	0.8507	0.8449	0.8173
SLG	0.8396	0.8423	0.8417	0.8253
MEL	0.8347	0.8468	0.8449	0.8252
SKT	0.8358	0.8505	0.848	0.8358
BCC	0.8002	0.8507	0.8449	0.8132

Similarly, on run-2, the BOA-FNNC algorithm has classified ANG with $sens_y$, $spec_y$, $accu_y$, and $F_{measure}$ of 0.8543, 0.8543, 0.8543, and 0.8543 respectively. In the meantime, the BOA-FNNC algorithm has classified NEV with $sens_y$, $spec_y$, $accu_y$, and $F_{measure}$ of 0.8326, 0.8469, and 0.8449, and 0.822 correspondingly. In parallel, the BOA-FNNC techniques have classified LNOS with $sens_y$, $spec_y$, $accu_y$, and $F_{measure}$ of 0.8055, 0.8507, 0.8449, and 0.8173 correspondingly. Simultaneously, the BOA-FNNC approach has classified SLG with $sens_y$, $spec_y$, $accu_y$, and $F_{measure}$ of 0.8249, 0.8423, 0.8386, and 0.8178 correspondingly. Parallelly, the BOA-FNNC technique has classified MEL with $sens_y$, $spec_y$, $accu_y$, and $F_{measure}$ of 0.8347, 0.8506, 0.848, and 0.8347 correspondingly. Also, the BOA-FNNC technique has classified SKT with $sens_y$, $spec_y$, $accu_y$, and $F_{measure}$ of 0.8173, 0.8467, 0.8417, and 0.8173 correspondingly.

Moreover, on run-3, the BOA-FNNC methodology has classified ANG with $sens_y$, $spec_y$, $accu_y$, and $F_{measure}$ of 0.8543, 0.8543, 0.8543, and 0.8543 correspondingly. In the meantime, the BOA-FNNC model has classified NEV with $sens_y$, $spec_y$, $accu_y$, and $F_{measure}$ of 0.8326, 0.8543, and 0.8512, and 0.8433 correspondingly. Ultimately the BOA-FNNC model has classified LNOS with $sens_y$, $spec_y$, $accu_y$, and $F_{measure}$ of 0.8055, 0.8507, 0.8449, and 0.8173 respectively. Simultaneously, the BOA-FNNC approach has classified SLG with $sens_y$, $spec_y$, $accu_y$, and $F_{measure}$ of 0.8396, 0.8423, 0.8417,

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and 0.8253 correspondingly. Parallelly, the BOA-FNNC technique has classified MEL with $sens_y$, $spec_y$, $accu_y$, and $F_{measure}$ of 0.8347, 0.8468, 0.8449, and 0.8252 respectively. Also, the BOA-FNNC method has classified SKT with $sens_y$, $spec_y$, $accu_y$, and $F_{measure}$ of 0.8358, 0.8505, 0.848, and 0.8358 correspondingly.

The training accuracy (TA) and validation accuracy (VA) acquired by the BOA-FNNC method on test dataset is demonstrated in Fig. 4. The experimental outcome implicit the BOA-FNNC technique has achieved maximal values of TA and VA. To be Particular the VA is greater than TA.

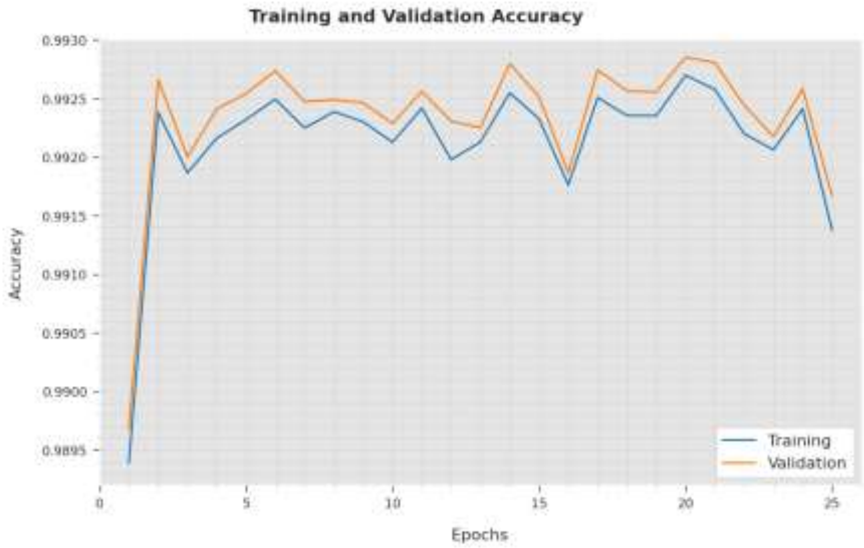

Figure 4: TA and VA analysis of BOA-FNNC approach

The training loss (TL) and validation loss (VL) attained by the BOA-FNNC method on test dataset are shown in Fig. 5. The experimental outcome implied that the BOA-FNNC algorithm has accomplished minimal values of TL and VL. Specifically, the VL is lesser than TL.

Figure 5: TL and VL analysis of BOA-FNNC approach

Table 2 exhibits an overall comparative examination of the BOA-FNNC model with recent models. Fig. 6 illustrates a detailed $sens_y$ study of the BOA-FNNC model with other existing models. The

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figure implied that the VGG-19 and ResNet50 models have shown poor performance with lower $sens_y$ of 92.86% and 92.44% respectively. Followed by, the Inception-v3 and LeNet approaches have shown slightly enhanced results with $sens_y$ of 95.55% and 95.16% respectively. Moreover, the CNN-Resnet 101 and AlexNet models have reported reasonable $sens_y$ values of 97.14% and 97.10% respectively. However, the BOA-FNNC model has accomplished higher performance with $sens_y$ of 98.37%.

Table 2: Comparative analysis of BOA-FNNC approach with recent methodologies

Methods	Sensitivity	Specificity	Accuracy
BOA-FNNC	98.37	98.37	99.27
CNN-Resnet 101 Model	97.14	94.76	92.09
VGG-19 Model	92.86	95.91	97.33
ResNet-50 Model	92.44	94.84	95.77
Inception-v3	95.55	94.32	96.19
AlexNet	97.10	95.72	96.32
LeNet	95.16	92.25	97.60

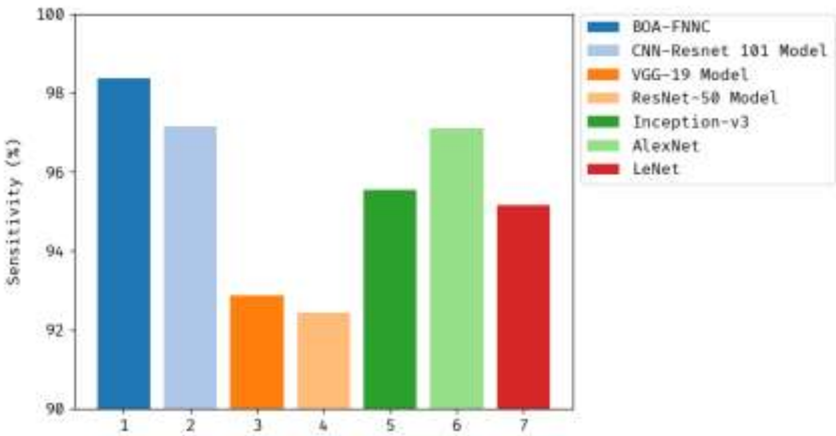

Figure 6: $Sens_y$ analysis of BOA-FNNC approach with recent methodologies

Fig. 7 portrays a detailed $spec_y$ study of the BOA-FNNC method with other existing models. The figure implicit the VGG-19 and ResNet50 algorithms have shown poor performance with lower $spec_y$ of 95.91%and 94.84% correspondingly. Next, the Inception-v3 and LeNet models have shown slightly enhanced results with $spec_y$ of 94.32% and 92.25% correspondingly. In addition, the CNN-Resnet 101 and AlexNet techniques have reported reasonable $spec_y$ values of 94.76% and 95.72% correspondingly. However, the BOA-FNNC approach has exhibited higher performance with $spec_y$ of 98.37%.

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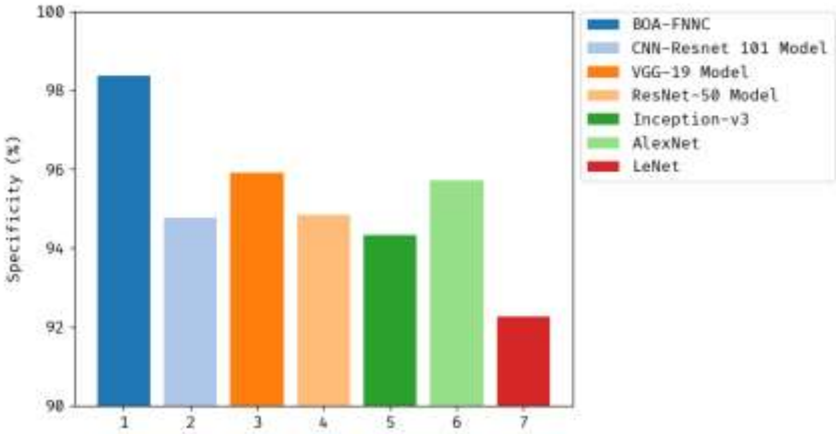

Figure 7: $Spec_y$ analysis of BOA-FNNC approach with recent methodologies

Fig. 8 shows a brief $accu_y$ study of the BOA-FNNC method with other existing models. The figure denoted the VGG-19 and ResNet50 models have displayed poor performance with lower $accu_y$ of 97.33%and 95.77% correspondingly. Then, the Inception-v3 and LeNet models have shown slightly enhanced results with $accu_y$ of 96.19% and 97.60% correspondingly. Besides, the CNN-Resnet 101 and AlexNet approaches have reported reasonable $accu_y$ values of 92.09% and 96.32% correspondingly. However, the BOA-FNNC algorithm has accomplished higher performance with $accu_y$ of 99.27%.

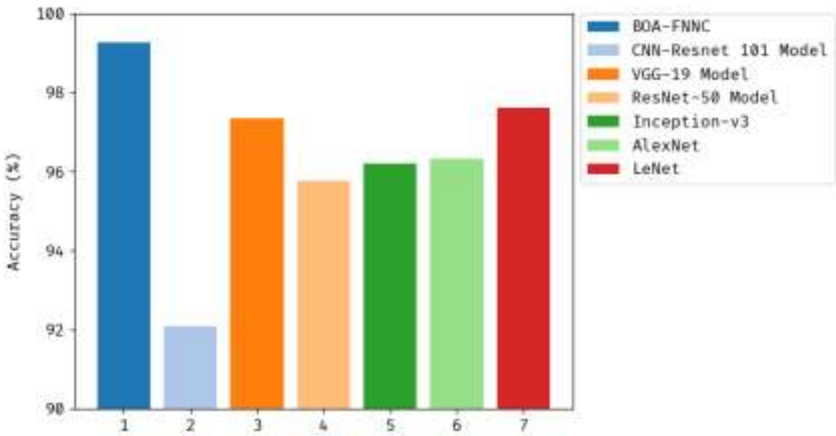

Figure 8: $Accu_y$ analysis of BOA-FNNC approach with recent methodologies

4. Conclusion

This article has introduced a BOA-FNNC Model for Blockchain Assisted Healthcare Data Fusion Environment. The presented BOA-FNNC technique mainly focuses on achieving security in the healthcare sector using BC technology. For accomplishing this, the BOA-FNNC technique performs BC assisted data transmission in the medical sector. Besides, the VGG-16 model is exploited for the creation of feature vectors. To classify healthcare data, the BOA with FNN model is utilized in this study, where the BOA fine tune the parameters related to the FNN model which in turn boosts the classifier efficiency. For illustrating the betterment of the BOA-FNNC technique, a series of experiments were performed. The comparison study reported the enhancements of the BOA-FNNC technique over other recent approaches.

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