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Detection of Human Diseases Using Neural Networks

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Abstract: *In our society human healthcare is one of the most important topics. It attempts to find the correct effective and robust disease detection as soon as possible so as the patients get the idea for appropriate care. As this task of detecting the disease is quite a difficult task, the medicine field searches is certainly supported with other fields like statistics and computer science. The objective of this research paper is to achieve the higher classification results in the disease detection. In the paper, artificial neural networks (ANN) algorithms are used for diagnosis of heart and nephritis diseases more accurately and convolutional neural networks (CNN) algorithms are used for the diagnosis of chest diseases. In this paper, conventional and deep learning approaches are used to illustrate the feasibility of classifying the chest X-rays. An important mechanism of medical diagnosis decision support is classification. Feed Forward propagation neural network and back propagation neural network are used as classifiers to differentiate between the infected and non-infected person.*

Keywords: Data Mining, Privacy, Preservation, Security, Human Disease, Machine Learning, Artificial Intelligence, Big Data

I. INTRODUCTION

Data mining is used to extract the most important data from the given database [1]. Due to the huge and fast growth in the amount of the digitally cumulated and stored medical data, the science of data management and analysis is also getting boosted to convert this huge resource into information and knowledge that helps them to achieve their objectives. The term Big Data (BD) which started with huge-volume, heterogeneous, autonomous sources with distributed and decentralized control, and it seeks to survey the complex and evolving relationships among data. BD is a subset of Data Mining (DM), also known as knowledge discovery in databases [2].

The human healthcare is one of the most crucial matters in human societies, as it directly relies on the quality of the life of the citizens. However, the healthcare department is highly diversified, widely distributed and disintegrated. According to the clinical perspective, it is necessary to deliver the appropriate patient care along with the access of suitable patient information whenever and wherever needed. Additionally, the wide variation in test-ordering for diagnostic purposes suggests the requirement of sufficient and appropriate test set [2]. Thus, a wide range of heterogeneous variables, gathered from different sources, such as demographics, disease history, medication, allergies, biomarkers, medical images, or genetic markers, each of which offer a different partial view on a patient's state is often included along with the medical data [2].

Study of the genetics of inherited diseases traditionally requires expertise in the diagnosis of disease status, even if the disease is genetically determined by alleles at a single locus. Due to the inconsistency of the diagnostic criteria, variable age at onset, and different appearances of the disease, it is often difficult to make a clear calculation of the affected status. To map the loci of such diseases, it is important to ensure that there is a high probability that one is dealing with a homogeneous genetic trait and that disease status can be determined with a high level of reliability [3]. In the present time, we have discovered an alternative approach to classify the disease status, which is done by implementation of artificial neural network analysis to the data available. A neural network can be thought of as a

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highly interconnected set of nodes or neurons that process information in parallel [3]. Medical X-rays are the images which are normally used to detect some sensitive parts of the human body such as bones, chest, teeth, skull, and so on. Medical professionals have been using this technique from various decades for visualizing and exploring fractures or abnormalities in body organs, this is possible because of the effective diagnostic tool known as X-rays. By analyzing the chest X-ray image, the radiologists can diagnose many conditions and diseases such as pleurisy, effusion, pneumonia, bronchitis, infiltration, nodule, atelectasis, pericarditis, cardiomegaly, pneumothorax, fractures, and many others.

Since the classification of X-ray abnormalities is more of a tedious job, many algorithms proposed by researchers are used to achieve this job. Since then the X-rays were left for the doctors to makes decisions.

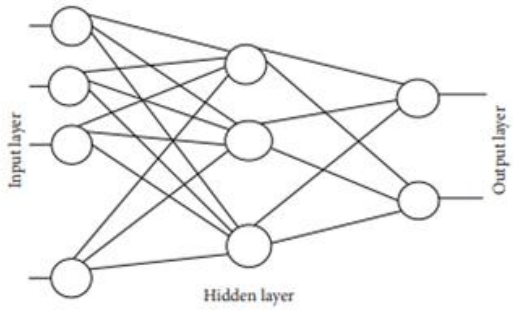

Figure: Backpropagation neural network

Zhang, Yan, Zhao and Zhang presented a method for developing a fully automated computer aided diagnosis system which helped the radiologists for detection and determining micro-calcifications in digital format mammograms. Higuchi, Sato, Makuuchi, Furuse, Takamoto and Takeda tested a three-layered artificial neural network analysis of phonocardiogram recordings to diagnose, automatically and objectively, the condition of the heart in patients with heart murmurs.

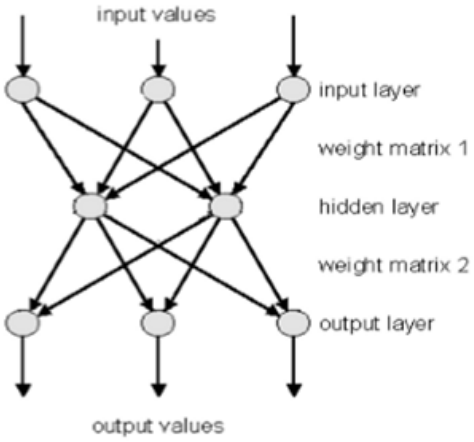

Figure: A typical neural network

II. Materials and Methods

A) Data Aggregation with Privacy Mechanism

In this module, a method introduced named as PPDM which is built based on the efficient privacy-preserving fully homomorphic data aggregation. The main aim of the data aggregation is ensuring the privacy as well as security concept in the existing scenario. The data aggregation is the process of combining uique information of patient details in the dataset and it is in the terms of addition and multiplication operation since for privacy with security mechanism.

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a) PPDM1 Technique

- **Key generation:** It uses the concept of aggregation of jet generation procedure steps for privacy. Authoried persons and patients maintain the secret keys privately. N = pq can also be selected by the patients in the next step PPDM1.Enc, and the knowledge of N-factoring is required to be privately kept.
- **Encryption:** It use the aggregation of encryption concept to encrypt each element in modules. They are performed by patient's information and the authorized physician in the health care centre.
- **Evaluation:** It is observed that only multivariate polynomials composed of addition and multiplication operations, are required to compute.
- **Decryption:** The authorized people processing the secret key namely the knowledge of factoring the composite N. Aggregation decryption fixes some threshold values and based on this value, we can conclude that the patient is suffering or recovering from one specific disease.

b) PPDM2 Technique

- In this module, a secure and efficient privacy-preserving medical image feature extraction scheme is introduced holds the property of full homomorphism, the issue of representing and extracting medical image features can be realized in the encrypted domain while retaining the inherent properties when operating in the plaintext domain.
- Difference of- Gaussian (DoG) is a technique for extracting the features from the specified images. Then, feature points are chosen as local extreme of the DoG image occurring at multiple scales.
- The medical Dog image generated from neighboring scales ρ_i and ρ_jis symbolized as

  $$DoGImg(x, y, \rho\_i, j) = ConvG(x, y, \rho\_i) - ConvG(x, y, \rho\_i)$$

  Where $1 \le x \le X$, $1 \le y \le Y$, X, Y respectively refer to the horizontal and vertical size of the medical image the convolution of the medical image with Gaussian Kernal G which is defined as for any x and y,

  $$ConvG(x, y, \rho\_i) = G(u, v, \rho_i) * I(x, y) = \Sigma_{u,v} G(u, v, \rho_i)\, I(x-u, y-v)$$

  Where * identifies the convolution process.
- **Achieve Security:** In this module, perform the feature point detection by using encrypted data comparison. The encrypted feature descriptor matching step compares the descriptors of the medical image collected from the patient and the template medical image from the authorized physicians by computing the similarity value via some certain judging metric.
- **Classification technique for disease prediction:** In this module, Gray Level Co occurrence Matrix (GLCM) feature method is proposed for efficient feature extraction to improve the classification of disease accuracy for the given dataset. And also introduced classification algorithms such as
- **SVM Algorithm:**

  Candidate Support Vector (SV) = {closest pair from opposite classes}
  While there are violating points do
  Find a violator
  CandidateSV = candidateSV ∪ violator
  If any α_p<0 due to addition of c to S
  Then
  CandidateSV = candidateSV\p
  Repeat till all such points are pruned
  End if
  End while

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B) Neural-Network Training Strategies

a) Back Propagation Neural Network (BPNN)

Backpropagation neural network (BPNN) is a multilayer feedforward neural network that uses a supervised learning algorithm known as error back-propagation algorithm. Errors accumulated at the output layer are propagated back into the network for the adjustment of weights. Figure 2 depicts a conventional BPNN which consists of three layers: input, hidden, and output. As seen in Figure, there is no backward pass of computation except the operations used in training. All the functioning operations proceed in the forward direction during simulation. The pseudocode algorithm for BPNN is given below:

- Network initialization: randomly choose the initial weights
- Select first training pair
- Forward computation that includes the following steps:
  1. Apply the inputs to the network
  2. Calculate the output for every neuron from the input layer, through the hidden layer(s), to the output layer
  3. Calculate the error at the outputs
- Backward computation
  a. Use the output error to compute error signals for preoutput layers
  b. Use the error signals to compute weight adjustments
  c. Apply the weight adjustments
- Repeat Forward and Backward computations for other training pairs.
- Periodically evaluate the network performance.

Repeat Forward and Backward computations until the network converges on the target output.

b) Feed – Forward Neural Network (FFNN)

- Feed-forward neural networks are widely and successfully used models for classification, forecasting and problem solving.
- A typical feed-forward back propagation neural network is proposed to diagnosis diseases. It consists of three layers: the input layer, a hidden layer, and the output layer.
- A one hidden with 20 hidden layer neurons is created and trained. The input and target samples are automatically divided into training, validation and test sets.
- The training set is used to teach the network. Training continues as long as the network continues improving on the validation set.
- The test set provides a completely independent measure of network accuracy. The information moves in only one direction, forward, from the input nodes, through the hidden nodes and to the output nodes.
- There are no cycles or loops in the network. The proposed neural networks are shown in

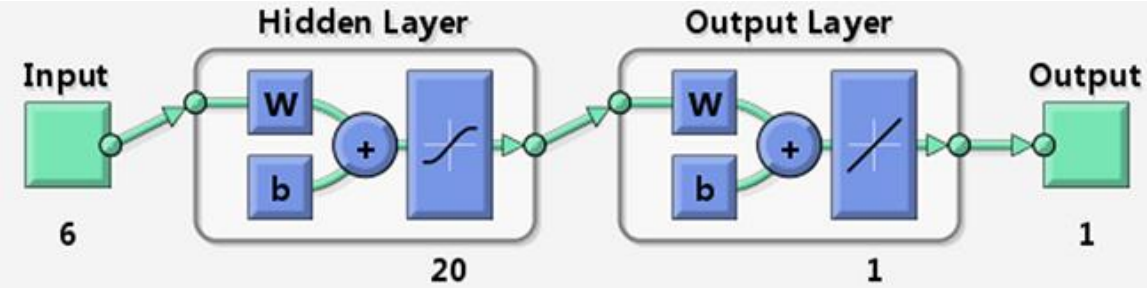

Figure: The proposed acute nephritis diagnosis neural network

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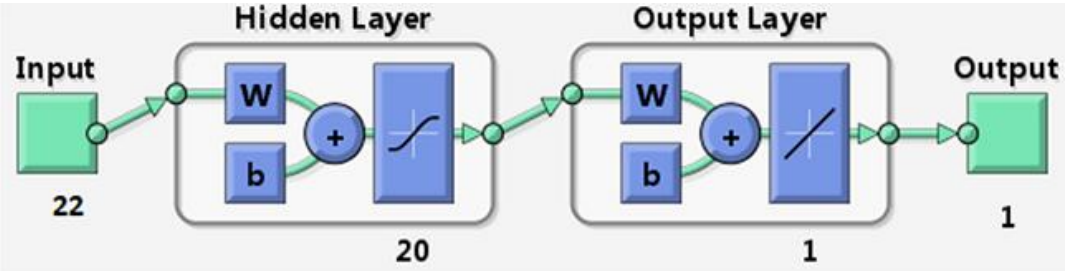

Figure: The proposed heart disease diagnosis neural network

- Feed-forward neural network allows signals to travel one-way only; from source to destination; there is no feedback.

III. Result Analysis

In the existing system, privacy and security are achieved using the PPDM1 and PPDM2 methods successfully. In the proposed system, diseased parts are efficiently identified by using an ANN classification algorithm.

- Precision: Precision is defined as the percentage of accurately predicted results from the set of input terms. In order to acquire the better system performance, the value of precision in the proposed methodolgy should be more than existing approach Precision is calculated by using following equation

  Precision = (True Positive)/(True Positive+False Positive)

- Recall: The recall or true positive rate (TP) is defined by the proportion of positive cases that were correctly identified, as calculated using the equation:

  Recall = (True Positive)/(True Positive+True Negative)

- Time complexity: In computation, the algorithms are estimated to reduce the time complexity. For number of files the existing and proposed methods are implemented in various time factor values. The less time execution values known as higher performance in the scenario which is provided by using proposed algorithm.

The Convolutional Neural Network (CNN) is designed for the diagnosis of lung disease. Back propagation neural network (BPNN) and competitive neural network (CpNN) are carried out for the classifying the chest radiographic diseases, to study the comparative analysis. The designed CNNs, BPNNs and CpNNs were studied and analyzed using chest x-ray images containing different diseases. Using different training parameters and a certain number of iterations, Several experiments have been carried out through the training of these networks.

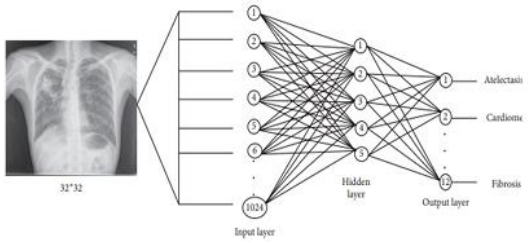

Figure: Backpropagation neural network (BPNN)

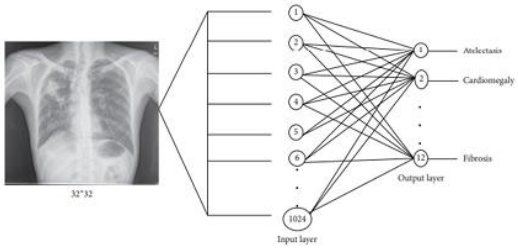

Figure: Competitive neural network (CpNN)

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A medical expert created the dataset in order to test the expert system, which will presumptively diagnose one of the diseases of the urinary system. The main idea of this dataset is to build the neural network model, which will perform the presumptive diagnosis of acute nephritis. Acute nephritis of origin of a renal pelvis occurs considerably more often at women than at men. It begins with sudden fever, which reaches and sometimes exceeds 40 ° C. The fever is accompanied by chills and lower back pains on one or both sides, which are sometimes very severe.

Patients symptom data	
No.	Diagnosis Variable Name
1	Temperature of patient {35C-42C}
2	Occurrence of nausea {yes, no}
3	Lumbar pain {yes, no}
4	Urine pushing (Continuous need for urination) {yes, no}
5	Micturition pains {yes, no}
6	Burning of urethra, itch, swelling of urethra outlet {yes, no}

Table 1: Diagnosis variable of datasets used in the study

The dataset describes the diagnosis of cardiac proton emission tomography (SPECT) images. Each of the patients is classified into two categories: normal and abnormal. The database of 267 sets of SPECT images (patients) was processed to extract features that summarize the original SPECT images. As a result, 44 continuous feature models were created for each patient. The model was then processed to obtain 22 binary feature models. SPECT data has 267 instances which are described by 23 binary attributes. The dataset contains 267 samples. 80 samples used in network training while 187 samples used to test the network.

IV. CONCLUSION

In this article, the conclusion decides that the proposed scenario produces superior performance rather than the existing scenario. Efficient privacy maintaining fully homomorphic data aggregation is introduced and illustration of disease is provided using the PPDM1 correlation matching method. And this is also ensured by the PPDM2 method of extracting confidentiality preserving medical image features. For benchmarking, back propagation neural network (BPNN) and competitive neural network (CpNN) are performed for classification of chest radiographic diseases. The designed CNN, BPNN and CpNN were trained and tested using chest x-ray images containing different diseases, the proposed classification method called artificial neural network is used to more efficiently discover and classify diseased images in the set data given. The experimental result showed that the proposed system is better in terms of precision recall and time metric.

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