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Liver Image Classification Using Exhaustive Classifier and Nature Inspired Algorithms

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Abstract
A significant internal organ of the human body is the liver. Its functions include the detoxification of poisonous compounds, creation of bile and albumin, the synthesis of lipids, carbohydrates, and proteins, as well as many other kinds of chemical elements used in daily life for food digestion. Hepatitis is one of the diseases that affect the human liver nowadays as a result of viral infections. Alcoholism causes fatty liver and cirrhosis illnesses, and medicines, chemicals, and pest control items in dietary goods induce liver problems. Hemochromatosis, Wilson disease, and liver tumors or cancer impact a significant number of individuals. Chronic liver conditions include cirrhosis, fibrosis, and chronic hepatitis. To detect its harms and for curing process, liver disorders are identified utilizing the widely used techniques such as tissue biopsies, blood tests, ultrasound effects, CT scans, and MRI.Paper gives a summary of the contribution of the researchers over the preceding five years to identify liver illness using medical images of the affected liver, artificial neural network algorithms. The goal of our proposed investigation approach is to distinguish between abnormal and normal liver, using six classifying methodologies to determine whether the liver is healthy or affected by diseases using medical images of the people. Nature inspired algorithms to do the feature selection task in our model as well avoid the unnecessary features which pulling down the performance. Methodologies includes SVM, eXtremeBoost, ANN, NB,CNN and LR. The said methods will be arranged with three unique algorithms in a group out of six, likewise it will be grouped the rest of them. The final results of exhaustive classifiers of each method's performance in their group will be compared with other combination of methods with their results from which the best performed combination will be identified to detect the liver issues and provide the additional treatment recommendations will then be made, which will bemore useful to doctors and individuals globally in themodern era, who are all affected by liver disease.

1. Introduction

As we know that the liver is the one of the major organ and plays the vital role in our human body. Liver is one among the biggest part of the body, which is situated in the right side of our body. The organ should be protected properly from any infections or from the harmful activities like consuming alcohol, otherwise due to serious liver illness; it may cause the human causalities. To do the early identification of the serious sickness of the liver by using various methods of diagnosis systems by which providing the proper treatment to save the human life threats. Artificial intelligence and its methods are playing the most significant role in the early analysis of the liver problems using liver images, like it is affected or not damaged through the proper investigation methods like MRI, CT, Ultra sound images and Biopsy. This procedure's classifier uses the RBFSVM, ANN, and random forest approaches. The accuracy and specificity of the SVM RBF technique in classifying liver tumors are unmatched. ANNs have a substantially higher level of sensitivity than other techniques.[1].The liver and its liver tumors segmentation challenge (LiTS-2017) dataset ,using the cancer are distinguished in a human abdominal CT scan. The research has further improved the model through including one Cbam architecture on top of the conventional U-Net network with a single mechanism for attention. The dataset is divided into 30 patient samples, with the remaining 100 patient samples

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being utilized as the a reliable and testable dataset of the validated and tested dice score for the liver in the segmentation are 98 and 91 percentages [2]. Based on the previous research and its performance of their used classifiers in the image classification, provides an avenue to do the research paper. In this research paper collection of human MRI liver images will be consider as and input dataset, the collected images will undergo for the using nature as inspiration to choose features algorithms by which totally eliminate the unnecessary features includes in the features by which it always avoids the degrading performance of the methods in the liver images classifications. The Exhaustive classifiers are SVM, eXtremeBoost, ANN, Random forest (RF), CNN and LRwill be used in terms of one class contains three different above specified algorithms, likewise many numbers of combinations will be arranged accordingly (i.e.NC=n C r, which means each class contains three different algorithms[r], in the same way number of classes will be arranged and termed as TC , whereas TC = 20.Finally the best performer class will be identified.

2. Problem Statements

1. CHRONIC LIVER DISEASES

Multiple metabolic operations, such as the storage and generation of glucose, detoxification, the production of digestive enzymes, the control of erythrocytes, protein synthesis, and other metabolic processes, are performed out by the liver.

A. Cirrhosis

Cirrhosis is liver scarring, which brought on by continual liver damage.

B. **Fibrosis**

Hepatic, fibrosis, or the excessive development of extracellular matrix proteins, is one of the most prevalent types of chronic liver diseases, including collagen.

C. Chronic hepatitis

The Hepatitis c-Virus infection that lasts for a very long time is known as chronic hepatitis-c. Before the liver is sufficiently harmed, chronic hepatitis-c typically persists as an undetected infection for years, by the virus to show signs and symptoms of liver disease.

D. Liver Cancer

A condition known as primary liver cancer occurs, when the tissues of the liver produce malignant (cancer) cells. Primary liver cancer is a different type of cancer from cancer that starts elsewhere in the body and travels to the liver.

1. Causes of Liver Diseases

An autoimmune reaction or a viral infection can cause hepatitis (such as the hepatitis C virus). Inflammation brought on by a hepatitis infection can cause liver tissue loss and scarring. Cirrhosis, a severe form of liver injury and scarring, is separated from fibrosis, a mild type of scarring. Fibrosis and cirrhosis can also be caused by non-alcoholic fatty liver disease and alcohol,ism. If liver illness is detected early i.e, between infection and fibrosis but before cirrhosis, liver failure can be avoided. By identifying and controlling hepatic issues at an early stage helps prevent liver failure.

2. Stages of liver diseases

The first of the four stages of liver disease is marked by inflammation, and patients may or may not have any indications. The second stage of the illness, fibrosis, which is generally usually asymptomatic, starts when chronic inflammation causes the growth of scar tissue instead of healthy liver tissue. Cirrhosis, the third stage of the illness, is brought on by significant liver scarring. During this phase, the patient starts displaying symptoms like nausea, vomiting, weakness, jaundice, and so on. The hallmark of end-stage liver disease (ESLD) is a marked decline in liver function (ESLD). Many variables may contribute the growth of the diabetic in the modern period; include high blood sugar, insulin sensitivity, and obesity.

3. Available testing modes to detect the liver diseases

- Blood test and HCV Antibody test in blood
- Ultra Sound
- Biopsy
- HCV Antibody test in blood
- CT scan
- MRI scan

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- PET scans

3. Related Works

The Hu, Yaqi et.al [3] proposed model used such as Naïve Bayes, Classification and Regression trees,and support vector machines (SVM), all of which incorporate 12-fold cross-validation,for the prediction of liver cirrhosis illness Deivendran et al [4]. The model's performance was assessed using accuracy, precision, recall, and F1 Score Rai, Rebika et al[16]. SVM technique yields the greatest results out of all the methods employed in their proposed model, with accuracy, precision, recall, and F1 Scores Nisa, Mehrun et al[17]. The research demonstrates that machine learning techniques, particularly the SVM et al[15], provide a more precise forecast for liver cirrhosis illness. It will be used to assist doctors in making more informed clinical judgments.

The study of Deivendran et.al [5],in that patients echo patterns in ultrasound imaging of disorders associated with liver illness, like fatty liver, cirrhosis and hepatomegaly are distinctive Sun, Bao-Ye et al[18]. The number of ultrasonic imaging errors and speckle noise make it challenging to recognize and frequently difficult to separate these echo-texture patterns visually Choudhary et al[19]. They proposed an artificial neural network based on the features derived from the ultrasonic pictures to diagnose disease states Wadhwa et al[20] in the liver and discover the best classifier that can distinguish the normal and abnormal level of the liver Baitharuet al[21]. As mixed feature set was found to be the best set of feature selection after evaluating the overall results of each feature classifer Yankovy et al[22]. The accuracy rate for the training data set was very high. When the network was smaller, GRLLM or grey level run length matrix feature exhibits superior performance Niss,mehrun et al[7].

According to deivendran et.al[5] in their investigation, there has been an increase in liver-related procedures, diagnoses, and therapies et al[23]. Parallel to this, cutting-edge computer systems controlled by AI continue to demonstrate their effectiveness in the precise detection, evaluation, forecasting, treatment, and recovery of liver-related illnesses Rahman et al[24].AI has demonstrated its intrinsic value for liver surgery operations while offering patients improved healing prospects and individualized care. Doctors, Liliet al[25] can more effectively educate patients and improve medical wellness by utilizing Deep Learning (DL) to analyze vast biological data. Data scarcity Rahman, Hameedur et al [26], model interpretability, privacy and ethical concerns, as well as heterogeneity, may be problems and barriers to the use of deep learning in computational medicine. Future uses of deep learning in the medical and health fields are guided by ML and DL, Balamurugan et.al [8], this study suggests using two different types of algorithms. The first technique, which is based on traditional machine learning, classifies objects using texture data Othmanet al [27]. Evaluation done based on the classifying algorithms such as KNN, RF,SVM,BayesNaive Rathish babu et al[9]. The second technique suggests a semantic segmentation model using convolutional neural network to implement semantic image segmentation. The model will help the extent and severity of anomalies in liver diseases are estimated by radiologists and medical physicists.

The jamilaet.al [10], deeply discussed about the strategies that has been most actively researched in recent decades is deep learning algorithms (DL). In terms of data mining and quantitative image evaluation, it performs admirably choudhary et al[19]. The potential of the DL models, which are mostly utilized for image segmentation, image analysis, and lesion detection, was not well discussed in the majority of recent studies. The newest craze in medicine and a common clinical technique is called DL-assisted medical decision making. The sun et.al 18] discussed about the early detection of abdominal aging and the identification of risk factors for its phenotype could postpone the onset of such disease. Then, using 45,552 &36,784MRI of the liver and MRI of pancreatic to train convolutional neural networks to estimate age, they created the first abdominal age et al deivendran[28]. According to attention maps, the prediction is influenced by nearby organs and tissue as well as the anatomy of the liver and pancreas.

The wadhwa et.al [20],used the discipline of image segmentation, the multilevel thresholding is regarded is a prominent and important topic of research. NioAs is an acronym for Nature inspired optimization algorithms. alternative model to be used extensively to address issues with MLT. This work provides a familiar assessment of unique NIOA developed over the past three years (2019–2021) while highlighting and examining the key difficulties faced while creating image multi-thresholding models based on NIOA. The Nisha et.al[10] used a convolutional neural network to

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implement semantic image segmentation (SIS) in our model (CNN). The trained model divides CT scans into five groups representing different diseases.The study says that texture analysis techniques may distinguish between and detect abnormalities in the human liver.

The Sun and Kalyan et.al [11], closely researched the significant medical and MR imaging data of HCC patients having surgical resection with DL support for noninvasive MVI prediction. Proposed predictive model, which incorporates deep learning and serum AFP levels, performed well in MVI and clinical outcomes are predicted in HCC patients.The Taha et.al[12], discussed based on several evaluation measures, including F-score and classification accuracy, tests of SVM, Random forest, Gradient Booster, and Naive Bayesian algorithms were conducted. Given that the better accuracy for said logistic regression is 71%.The tanwar et.al[13], the goal of their study is to assess how well SVMs and ANNs perform at classifying patients, and to use k-fold cross validation and hyper parameter adjustment to increase ANN accuracy. According on the experimental findings, ANNs outperform SVMs. The findings may aid in the diagnosis of liver conditions by doctors.

Researchers Baitharu and Tapasyusn et.al, [14], using The decision tree algorithms J48, Naïve Bayes, ANN, ZeroR, 1BK , and VFI in the research to categorize these illnesses and compare their efficacy and rate of rectification. This study offers a comparative investigation of data categorization accuracy utilizing data on disease states in various settings Le goallec et al[15]. Authors discover that all of the aforementioned classifiers have generally better predictive performance, however Naive Bayes performance is really not remarkable. In this study, classification algorithms were employed to detect liver disease.

4. Classifiers and Nature Inspired Algorithms

A. Artificial Neural Networks(ANN)

The below Fig.1.1 deals with the deep neural networks, which are what drive deep learning, are ANNs that have more than three layers, such as an input layer, an output layer, and several hidden layers.ANN includes learning techniques including Kohenen, radial bias, and feed-forward neural networks.

A. Convolutional Neural Network(CNN)

CNN is a specific kind of deep learning network design that is used for processing pixel data and performing image processing. Despite the differences forms of deep learning neural networks are there, whereas CNN remain the most common network design for detecting and classifying things.

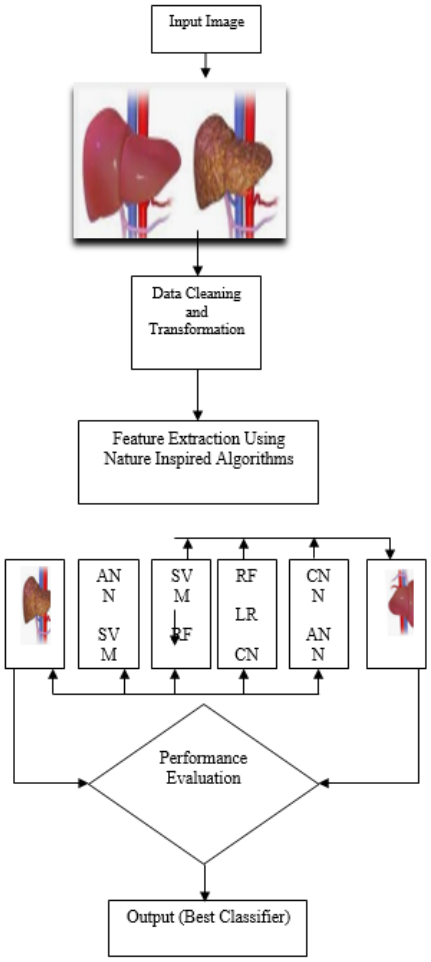

Figure 1.1 Classifier Architecture

B. eXtremeBoost

The eXtremBoost technique is a scalable, distributed gradient boosted decision tree (GBDT) machine learning framework. One of the most potent machine learning libraries is provided for regression, classification, and ranking challenges, as well as parallel tree boosting.

C. Random Forest(RF)

After several decision tree classifiers have been fitted to various subsamples of the input sets, the Random forest is a met estimator that uses averaging to improve forecast accuracy and reduce over fitting.

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D. Support Vector Machine(SVM)

Support vector machines (SVMs), a type of deep learning system, use supervised classifiers to learn or comprehend the results of data groupings, The input and intended output data from supervised learning systems in AI and ML are categorized for the identification process.

E. Logistic Regression(LR)

The Machine learning uses the categorization method known as logistic regression method. So the dependent variable is represented using a logistic method. Assuming that the dependent variable is dichotomous, there are only two potential classes.

F. Nature inspired algorithms

Any optimization algorithm is a procedure that is repeated while assessing many solutions to get the best or most workable one. Optimization has been included into CADD jobs ever since the development of computers.

5. Methodology and Performance Analysis

The below Table 1.1 gives the various Performance analysis of the different types of models tested and also implemented using different methodologies, finally the best performance of the accuracy is 95% of SVM and 99% of DL.

Table 1.1 Performance Measurements

Year	Methodologies tested	Best Methodologies Identified	Performance Measurement	Authors	Title	References	Dataset
2022	SVM	SVM	Accuracy: 73% Precision: 73% Sensitivity Recall: 100 F1-Score: 84%	Jamila et.al	Using machine learning techniques, a diagnostic model for the prediction of liver cirrhosis is presented.	[3]	Federal Medical Centre, Yola, 583 patient records with 11 attributes
2022	• KNN • NB • SVM • RF • Semanticimagesegmentation(SIS) using CNN	Texture analysis techniques with CNN	Accuracy >95%	M.Nisa et.al	Analysis of Liver tissues by deep convolution neural networks using CT images	[10]	3000 CT imaging data of 71 patients from the Bahawal Hospital, Bahawalpur, Pakistan
2022	• DL with predicted MVI status • Multivariate LRs	DL-MVI and LR	AFP,MVI, and DL worked together to produce an area under the curve of 82.4%	Sun, Bao-Ye, et al	Preoperative MRI deep learning analysis forecasts microvascular invasion and prognosis in hepatocellular carcinoma	[11]	Dataset contains 321 HCC records

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2021	• SVM • RF • Gradient Booster • NB • LR	Logistic Regression	F-Score :81% Precision:72% Recall: 92% Accuracy: 70.54% overall 71% accuracy with LR	Choudhary et.al	A powerful model for diagnosing liver disease using a convolutional neural network and textural statistics from ultrasound investigation to classify liver diseases	[12]	ILPD repository-416 liver patients and 167 records of non-affected patients
2021	• Texture analysis with CNN	Texture analysis with CNN and MLP	Alldisease classification accuracy : 87 %	Yankov et.al	classifier of Liver Diseases According to Textural Statistics of Ultrasound Investigation and Convolutional Neural Network	[15]	Data set contains 210 US images collected from Institute of the national academy of medical sciences of Ukraine's nuclear medicine and radiation diagnostics
2021	• XGBoost algorithm with an AUC	XGBoost algorithm with an AUC	AUC performance is 89%	Zhao et.al	Model for predicting fatty liver disease based on electronic physical examination records' big data.	[16]	Dataset contains 44,854 patients records from Health database of china
2019	• LR • K-NN • DT • SVM • NB • RF	LR	Performance Accuracy:75%	Rahman et.al	A comparison of supervised machine learning techniques for predicting liver disease	[17]	UCI Machine Learning Repository contain 583 records of the human

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2019	• SVM	SVM with two cross validation of AUC is 0.84 and0.77 are radiomic and clinical results respectivel y	accuracy is 81.8%, sensitivity is 72.2%, specificity is 87.0% for the internal validations whereas accuracy is 74.0%, sensitivity is 64.6%, specificity is 83.4%, and AUC is 0.80 for the external	He Lili, et al.	Using clinical and T2-weighted MRI radiomic data, machine learning can predict the stiffness of the liver.	[18]	255 records from Cincinnatian children's' hospital medical centre are included in the dataset.
2022	• DL - ResUNet	hybrid deep learning ResUNet	Accuracy:98%	Rahman, Hameedu r, et. al	Using ResUNet and deep learning, segment the liver and tumour in CT images.	[19]	IRCADB01-Public 3D CT image dataset
2022	• DL – ResNet50	DL – ResNet50	Accuracy rate more than 99%	Othman, Esam, et al.	Liver cancer automatic detection using hybrid pre-trained models.	[20]	3D-IRCADb-01 Dataset consists of 20 3D ct images and List17 dataset contains 130 CT images .

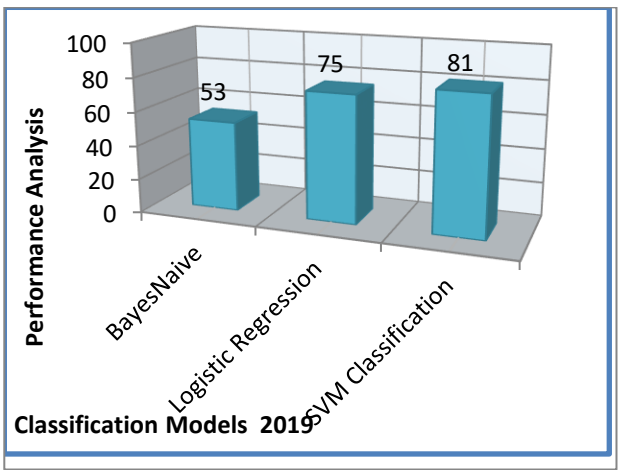

Figure 1.2 Classification Analysis 2019

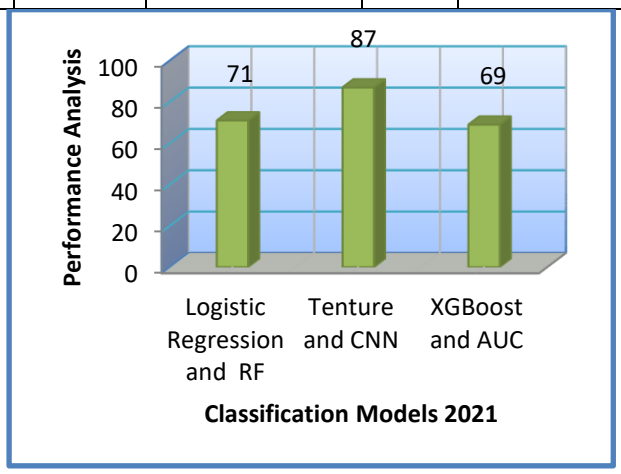

Figure 1.3 Classification Analysis 2021

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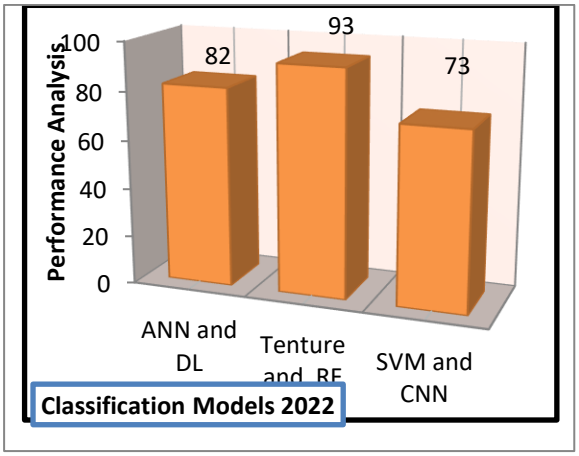

Figure 1.4 Classification analysis 2022

Above chart prepared based on the researches were done over the period of 2019 to 2022 in the field of liver disease identification using medical images of the patients. The chart prepared using tableau software, which clearly shows that the recent works with the help of CNN with texture analysis will perform better than the rest of the other.

6. Classification Models

The methodology's aims to classify the liver medical MRI images using the models such as ANN,SVM,RF. Logistic regression. EXtremeBoost and CNN.Firstly, after the preprocessing of the MRI image dataset, applying a nature inspired algorithm to the feature selection in order to avoid the unnecessary features, only select the important feature, which will provide the good sign towards the results. Secondly to classifying the affected and non-affected liver based on the evaluation of each group performance to be compared with the rest of other groups of the exhaustive classifiers. Each groups are constructed with three different algorithms from the above said models. Finally, the best performer group will be nominated by which the proper guidelines as well future treatment suggestion can be made by the physicians to the humans.

Number of groups NC are estimated as follows:

$^{a}C_{r}$, which is NC is number of groups, r is number of unique algorithms in each group, So finally NC is equal to 20 groups.

$$^{a}C_{r} = a! / r! (a-r)! \quad (1)$$

$$NC = {}^{6}C_{3} = 6! / 3! (6-3)! = 20 \quad (2)$$

Input: MRID

VOTEY=0;

VOTEN=0;

Method = array (SVM, eXtremeBoost(eb), ANN, LR, RF, CNN) in other form i is consider as method as we have six methods,

i = (1=> SVM, 2=>eb,3=>ANN,4=>LR,5=>RF,6=>CNN)

Number of combinations [$^{n}c_{r}$, i.e., n= 6[n => six unique methods],

r = 3[r => unique combination of three methods out of six],

then

total number of combination is $^{6}C_{3}$= 20]

```
for (i = 1; i< = 6; i++)
        for (j =i+ 1; j< = 6; j++)
                for (k = j+ 1; j< = 6; k++)
                        If (I = =j OR I = = k OR j = = k)
                          Continue;
                        End if
                        for each (MRID as MR)
                                If (MR[Y] = = Y)
                                 VOTEY = VOTEY + 1
        elseif (MR[N] = = N)
        VOTEN= VOTEN+ 1
   Elseif ((MR[Y] = = N)
VOTEYN= VOTEYN+ 1
    Otherwise
            VOTENY= VOTENY+ 1
End if
```

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end for each

end for

end for

end for

The above method or algorithm is used to find the affected liverimages [YES] ,based on the already existing labels of each input image in each algorithm in each group, likewise for the rest of the groups in the 20 combinations will be calculated for the both predicted class and probability class of its confidence level. As like that the non-affected images [NO] based on the already existing labels of each imagein all the combinations group (i.e.20) of the six methods which are involved in this research will be calculated for the both predicted class and probability class of its confidence level.

The predicted and probability class voting average will be calculated based on thatthe best group will be nominated.

(1) $Avgpr_1=G1prcl(i,j,k)/r, Avgpr_2=G2prcl(i, j,k+1)/r,..AvgprN = GNprcl(i_n,j_n,k_n)/r$ (3)

The predicted class average of each group will be calculated, and then based on that the majority voting of the group will be identified.

(2) $Majorityvotingprcl=MaxAvgpr_1,Avgpr_2…...Avgpr_{20)}$ (4)

(3) $Avgprbcl1=G1prbcl(i,j,k)/r,….$

(4) $Avgprbcl20= G20prbcl(i_n, j_n,k_n)/r$ (5)

The probability class average of each group will be calculated, and then based on that the majority voting of the group will be identified.

(5) $Majorityvotingprbcl=Max(Avgprbcl_1,Avgprbcl_{20} …..Avgprbcl_{n)}$ (6)

(6) [Note: G means group which contains three unique algorithms, i=1 to 6,j=i+1 to 6,k=j+1 to 6, r is number of unique algorithms, Avg1,Avg2...Avg20 are average voting of each group of predicted classes and Avgprbcl1…Avgprbcl20 are average voting of each group's probability classes]

7. Conclusion

One of the vital organs is the liver. Prior detection of liver damage can allow the patient receive the necessary treatment to recover from the illness.Otherwise, the damage will worsen and eventually could be fatal to the patient. Our suggested exhaustive classifier model gathers the patient's MRI liver picture after proper needed feature selection and preprocessing with the use of nature inspired algorithms. With the aid of our six aforementioned algorithms, the results of each group will be examined and based on the voting method of the best performance for classification of damage and non-damage livers of the human. And present the helpful advice, which will be more helpful for the radiologist and the physicians in making medical decisions.Our model will be implemented with large amount of dataset of various liver diseases MRI images in the near future to help the global community from the deadly disease.

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