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SOFT-COMPUTING TECHNIQUES FOR FUNCTIONAL MRI BRAIN IMAGE CLASSIFICATION

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Abstract

The objective of this paper is to explore Artificial Neural Network (ANN) with Hybrid Model with reduced set of features and its comparison with various existing model. A model with high classification accuracy will be tried to develop. This research paper also tries investigating how the hybrid blend of Neuro-fluffy procedure mix of neural system and fluffy rationale methods can be applied for the characterization reason on the clinical field.

Key Word Artificial Neural Network (ANN), Hybrid Model, Neuro-fuzzy technique, Medical Image Segmentation, classifier

Introduction

With the quick change in innovation, there is headway in every single field. Undoubtedly, it likewise has regular advancement, as a result of its human persuade. The clinical imaging field, specifically, has developed significantly as of late and has created extra enthusiasm for techniques and devices for the administration, investigation, correspondence, and grouping of clinical picture information.

Order is one of the significant Applications of Neural system, Fuzzy rationale, Neuro-fluffy procedure, and wavelet neural system and these methods have developed as a significant device for characterization. Neural systems, Fuzzy rationale, and Neuro-fluffy procedures are a promising option in contrast to different traditional arrangement strategies. Ongoing explores clinical picture characterizations utilizes diverse hybridization methods.

Noteworthy Contribution

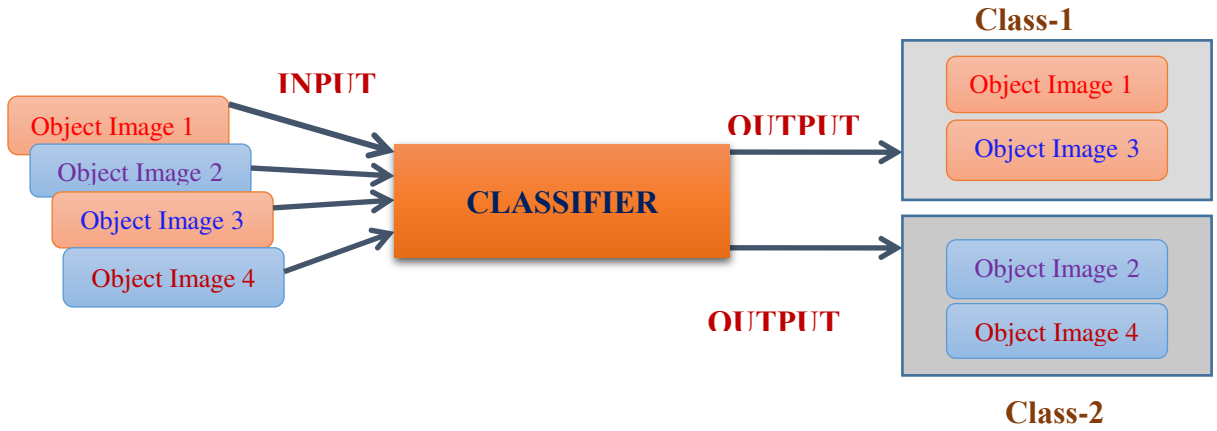

Figure 1: Image classification process

Medical image segmentation and classification is an emerging field of research from last two decades. After reviewing a number of papers related to medical image classification, we found that various approaches like region based approaches, neural network based , wavelet transform based, fuzzy logic based approaches etc. has already been implemented. All these techniques have their individual drawbacks. These problems can overcome by implementing a soft computing based system.

S.N.	Objectives	Techniques	Outcomes
1	Segmentation of MRI images [1]	Adaptive Fuzzy Leader Clustering Algorithm (AFLC)	The proposed AFLC algorithm provides the Misclassification Rate for Gray matter- 4.46% White matter- 1.83% Cerebrospinal fluid- 4.11% Skull- 3.5% Average- 3.48%
2	Examination between a conventional RBF two-phase half breed learning strategy with a RBF two-phase learning method misusing named information [2]	RBF focuses are dictated by running another Enhanced Linde-Buzo-Gray (ELBG) grouping calculation	The overall accuracy of RBF-1 is reported as 85.9% and that of RBF-2 is 81.2%.
3	Automated Brain Tissue	Fuzzy and Evidential	The trial results are empowering

	Segmentation and MS Lesion Detection [3]	Reasoning	on the analyzed picture sets, with high generally speaking division exactnesses and great MS recognition execution. Nonetheless, the pre-owned presumption that MS is situated in WM territories debases the ability of the methodology in MS location.
4	MRI image Clustering [4]	Fuzzy Logic	Error is in acceptable range in anatomical structures in MR brain image
5	Segmentation of Medical Images of the Brain [5]	An altered Fuzzy c-implies (FCM) calculation is actualized	It is found from the exploratory outcomes that the proposed strategy performs better than the k-implies, ordinary FCM and RBFNN strategies
6	Novel method of segmentation of MRI image [6]	Fuzzy c-means and K-neareast neighborhood	This integrated approach yields a robust and precise segmentation as compare to conventional techniques.
7	medical image segmentation [7]	Unsupervised Linear Discriminant Analysis (ULDA)	ULDA is contrasted with and Fuzzy C-mean for the clinical picture division. A few examination results show that the ULDA has vastly improved powerful division for multispectral MRI pictures and is vigorous to the commotion aggravation in the picture.
8	Clustering and segmentation [8]	Weighted Fuzzy C-means	The outcomes show that WFCM accomplishes prevalent exhibitions for low SNR

			conditions, though a Gaussian blend model is alluring for high commotion levels.
9	Data Mining based Classification [9]	Data Mining based Classification	The consequences of the tests have indicated that the quantity of classes, signal-to-clamor proportion, and volumes of actuated and investigated zones has[a solid impact on the ,classifier exhibitions.
10	Tissue characterization results [10]	Modified Problistic Neural Network (PNN)	Tissue characterization results from different calculations are analyzed, and the viability and power of the proposed approach are shown and discovered better
11	Brain injury Detection [11]	(SVM) SupportVvector Machine - Based Classifier.	Accuracy is 94.1% by using the trained support vector machine (SVM)-based classifier.
12	Statistical Analysis [12]	Statistical Techniques	FMRi image classification result was found satisfactory
13	Classification of brain MRI [13]	Extension Neural Network	proved that Extension is superior to the other algorithms in terms of classification.
14	Brain Tumour Detection [14]	Wavelet Transform, k-means algorithm	Some of test results on brain pictures show the plausibility and the execution of the proposed approach.
15	Brain Tissue Classification [15]	Multi wavelet Transformation and Probabilistic Neural Network	The order is done utilizing Weighted Probabilistic Neural Networks (WPNNs). The test results exhibit that the proposed

			calculation improves the characterization rate within the sight of commotion and within the sight of force non-consistency levels.
16	MR image segmentation [16]	Modified Partical Swarm Optimization (MPSO) Compared with Probiblistic ANN (PNN)	Suggested new hybrid model MAPNN with least error rate 5.60% as compared to FCM (7.99%),SVM (8.97%)and PNN (8.22%)
17	Classification of Brain Cancer [17]	Neuro –Fuzzy Classifier	The framework was discovered effective in characterization of tests and reacts any variation from the norm
18	Classification of MR Images [18]	Neuro –Fuzzy,Back Propogation Algorithm with Least Mean Square Method	The intertwined pictures dependent on neuro-fluffy rationale save more surface highlights, yet in addition improve the data qualities of two unique pictures
19	Brain Tumour Classification [19]	Probabilistic Neural Network , Feature Extraction through Principal Component Analysis (PCA)	The display of the PNN classifier was evaluated with respect to planning execution and gathering definite nesses. Probabilistic Neural Network gives speedy and exact portrayal and is a promising instrument for gathering of the tumors
20	Brain Tumour Detection [20]	Based upon Neural Network Brain Tumor is identified Using MR Images	The interdependency of two methodologies unquestionably makes exact discovery of censures cells

21	Classification of MRI Brain Images [21]	K-Neareast Neighborhood (K-NN) and ANN	This outcome shows that the proposed method is hearty and compelling contrasted and other ongoing work
22	Brain tumour Classification [22]	Gaussian Decomposition and Neural Networks	This blend of methods is appeared to yield high analytic order exactness in issues concerning different cerebrum tumor pathologies, some of which have gotten little consideration in the writing.
23	Classification of Brain Tumour [23]	Back Propagation algorithm of ANN (BPN) and using Radial Basis Function Neural Network (RBFN)	RBFNN outperforms BPNN in terms of accuracy and specificity
24	Brain Tumour Detection [24]	Detection of Brain Tumour using Modified Region Growth Technique	Adjusted district developing procedure got a superior amount rate for all the information pictures.
25	Automated Image Segmentation for MRI [25]	Three-Stage method is used to segment images.	Proposed calculation is utilized for Multiple Sclerosis injuries, for MRI-PET enlistment, and for considers including picture pressure, where the nonbrain locale is naturally given a higher pressure proportion than the mind district in the pictures.

Methodology

1) Fuzzy Logic

Zadeh [26] introduced the fuzzy set theory, which was oriented to the rationality of uncertainty due to imprecision or vagueness. A major contribution of fuzzy set theory is its capability of representing vague data. Fuzzy sets and fuzzy logic are powerful mathematical tools for modeling: uncertain systems in industry, nature

and humanity; and facilitators for common-sense reasoning in decision making in the absence of complete and precise information. The classical set theory is built on the fundamental concept of set of which is either a member or not a member. A sharp, crisp and unambiguous distinction exists between a member and non-member for any well-defined set of entities in this theory and there is a very precise and clear boundary to indicate if an entity belongs to the set. But many real-world applications cannot be described and handled by classical set theory. A fuzzy set is an extension of a crisp set. Crisp sets only allow full membership or non-membership at all, whereas fuzzy sets allow partial membership. Fuzzy numbers are the special classes of fuzzy quantities. A fuzzy number is a fuzzy quantity M that represents a generalization of a real number. Intuitively, M(x) should be a measure of how well M(x) "approximates"[27]. A fuzzy number M is a convex normalized fuzzy set. A fuzzy number is characterized by a given interval of real numbers, each with a grade of membership between 0 and 1. It is possible to use different fuzzy numbers according to the situation. Generally in practice triangular and trapezoidal fuzzy numbers are used. In applications it is often convenient to work with triangular fuzzy numbers (TFNs) [28] because of their computational simplicity, and they are useful in promoting representation and information processing in a fuzzy environment [28]. Fuzzy logic is used to test the medical image data for classification

2) Artificial Neural Network (ANN)

A Neural Network (NN), on account of fake neurons called Artificial Neural Network (ANN) or mimicked neural system (SNN) [29], is an interconnected gathering of characteristic or counterfeit neurons that utilizes a scientific or computational model for data preparing dependent on a connectionist way to deal with calculation. By and large an ANN is a versatile framework that changes its structure dependent on outside or inside data that courses through the system. neural systems are non-straight measurable information displaying or dynamic apparatuses. They can be utilized to demonstrate complex connections among sources of info and yields or to discover designs in data.Neural networks[30], as utilized in man-made consciousness, have generally been seen as streamlined models of neural preparing in the mind, despite the fact that the connection between this model and cerebrum natural engineering is discussed, as it isn't obvious to what degree fake neural systems reflect mind work. Neural Network gives quick and exact grouping and is a promising apparatus for characterization of

the tumors. Kinds of Neural Network: There are numerous sorts of Artificial Neural Network are clarified underneath:**2.1 2.1) Multi Layer Neural Network (MLNN)**

Multilayer networks solve the classification problem for non linear sets by employing hidden layers, whose neurons are not directly connected to the output. The additional hidden layers can be interpreted geometrically as additional hyper-planes, which enhance the separation capacity of the network. The architecture of multi layer neural network is depicted below in figure-2

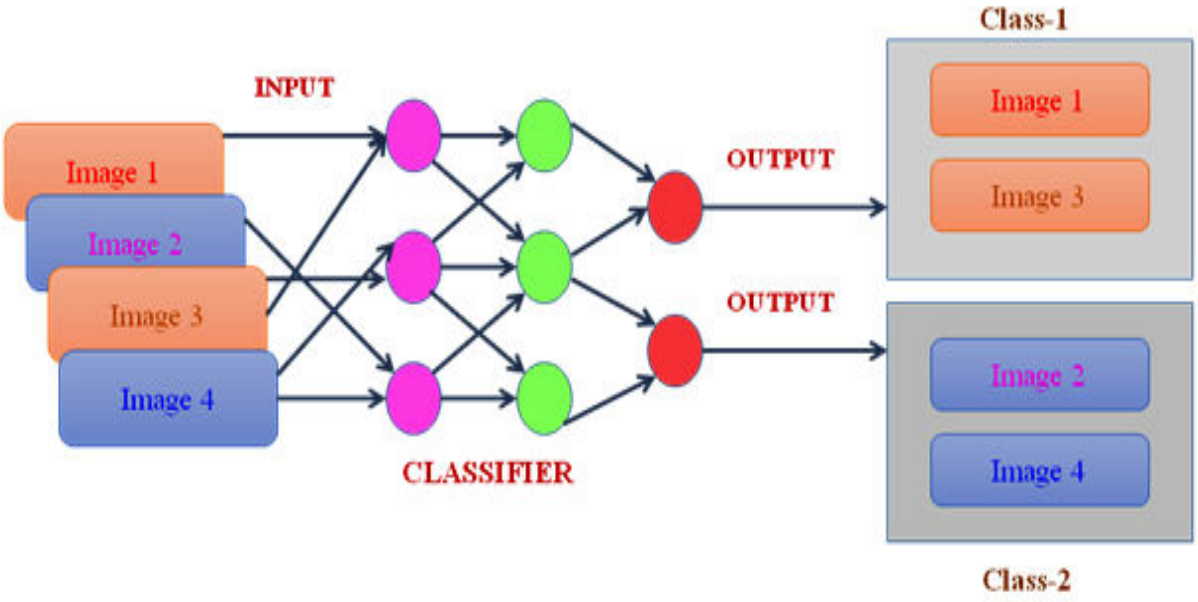

Figure 2: Architecture of multilayer neural network.

2.2) Polynomial Neural Network (PNN)

Polynomial neural systems (PNN) [31] are multilayer perceptrons of neuron-like units which produce high-request multivariate polynomial mappings. These are tree-organized various leveled falls of first-request and second-request enactment polynomials in the hubs, and info factors went from the leaves. The initiation polynomial results are taken care of forward to their parent hubs, where halfway polynomial models are made. This PNN topology follows the development of the multilayer GMDH[32] and permits creating high-request multivariate polynomials by making tractable actuation polynomials in the concealed system hubs. From a functional perspective, polynomial neural systems are computationally effective, for they permit parameter estimation by notable calculations like least squares.

2.3) Radial Basis Function Neural Network (RBFNN)

Radial premise capacities [32] are ground-breaking procedures for introduction in multidimensional space. A RBF is a capacity which has incorporated with a separation basis as for a middle. RBF neural systems have the upside of not experiencing nearby minima similarly as Multi-Layer Perceptrons. RBF[33] neural systems have the drawback of requiring great inclusion of the information space by spiral premise capacities.

2.4) Hybrid Techniques

Hybrid smart frameworks utilizing delicate processing strategies. Delicate Computing (SC) comprises of a few savvy processing standards, including fluffy rationale, neural systems, and developmental calculations, which can be utilized to create ground-breaking half and half canny frameworks.

3) Wavelet Transform and Neural Netwrk

Wavelet neural networks [34] combine the theory of wavelets and neural networks into one. A wavelet neural network generally consists of a feed-forward neural network, with one hidden layer, whose activation functions are drawn from orthonormal wavelet family.One applications of wavelet neural networks is that of function estimation. Given a series of observed values of a function, a wavelet network can be trained to learn the composition of that function, and hence calculate an expected value for a given input. The structure of a wavelet neural network is very similar to that of a (1+ 1/2) layer neural network. That is, a feed-forward neural network, taking one or more inputs, with one hidden layer and whose output layer consists of one or more linear combiners or summers. The hidden layer consists of neurons, whose activation functions are drawn from a wavelet basis. These wavelet neurons are usually referred to as wavelons.

3.1) Neuro-Fuzzy Technique

A fluffy neural system or neuro-fuzzy[35,36] framework is a learning machine that finds the parameters of a fluffy systemby misusing guess strategies from neural networks.This implies that the fundamental expectation of neuro fluffy methodology is to make or improve a fluffy framework consequently by methods for neural system methods.

The thought of a neuro fluffy framework is to discover the parameters of a fluffy framework by the methods for taking in techniques acquired from neural system. Contrasted with a typical neural system, association loads

and spread and enactment elements of fluffy neural systems vary a great deal. A neuro-fluffy framework dependent on a basic fluffy framework is prepared by methods for an information driven taking in technique got from neural system hypothesis. This heuristic just considers neighborhood data to cause nearby changes in the key fluffy framework. It tends to be spoken to as a lot of fluffy standards whenever of the learning procedure, i.e., previously, during and after. Consequently the framework may be introduced with or without earlier information regarding fluffy rules.

The learning strategy is compelled to guarantee the semantic properties of the fundamental fluffy framework. A neuro-fluffy framework approximates an n-dimensional obscure capacity which is incompletely spoken to via preparing models. Fluffy standards would thus be able to be deciphered as ambiguous models of the preparation information.

A neuro-fluffy system is a fluffy surmising framework in the body of a fake neural system. Contingent upon the FIS type, there are a few layers that reproduce the procedures engaged with a fluffy deduction like fuzzification, surmising, total and defuzzification. Installing a FIS in a general structure of an ANN has the advantage of utilizing accessible ANN preparing strategies to discover the parameters of a fluffy framework. Despite the fact that there are a wide range of ways to deal with model a fluffy neural system.

3.2) Adaptive Neuro Fuzzy Inference System (ANFIS)

ANFIS, created by Jang, joins the idea of fluffy rationale into the neural systems, and has been generally utilized in numerous applications. ANFIS is a versatile system. A versatile system is system of hubs and directional connections. Related with the system is a learning rule - for instance back spread. It's called versatile on the grounds that a few, or all, of the hubs have parameters which influence the yield of the hub. These systems are learning a connection among sources of info and yields. Versatile systems spread various methodologies yet for our motivations we will explore in some detail the strategy proposed by Jang known as ANFIS.

The ANFIS engineering is demonstrated as follows. The roundabout hubs speak to hubs that are fixed though the square hubs are hubs that have parameters to be scholarly.

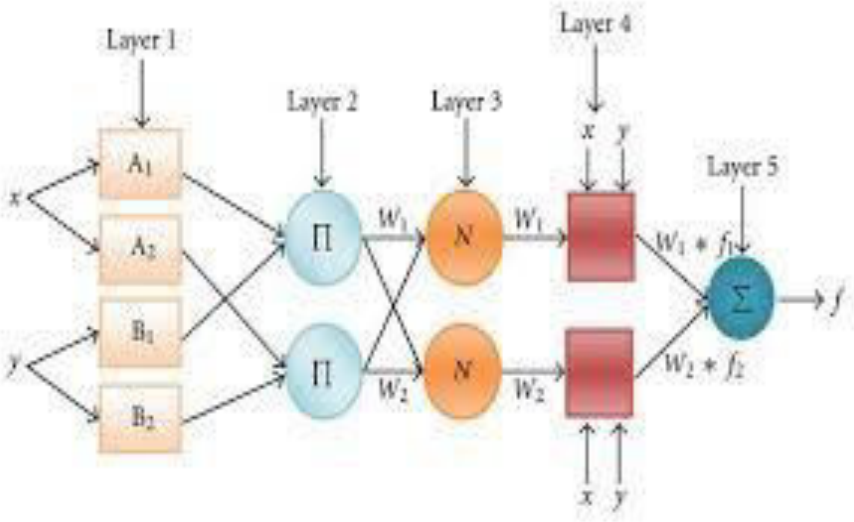

Figure-3: ANFIS Architecture.

A fluffy deduction framework executed in the system of versatile systems. By utilizing a half and half learning method, the proposed ANFIS can build an information yield mapping dependent on both human information (as fluffy on the off chance that rules) and specified information yield information sets. In our recreation, we utilize the ANFIS design to demonstrate nonlinear capacities, recognize nonlinear segments on-linely in a control framework, and anticipate a disorganized time arrangement, all yielding wonderful outcomes.

3.3) Neuro Fuzzy Control (NEFCON)

NEFCON[39] is intended to execute Mamdani type FIS and is delineated in Figure 5. Associations in NEFCON are weighted with fluffy sets and rules are the fluffy sets portraying the forerunners and consequents) with a similar predecessor use alleged shared loads, which are spoken to by ovals drawn around the associations. They guarantee the trustworthiness of the standard base. The information units accept the assignment of fuzzification interface, the deduction rationale is spoken to by the engendering capacities, and the yield unit is the defuzzification interface. The learning procedure of the NEFCON model depends on a blend of support and backpropagation learning. NEFCON can be utilized to become familiar with an underlying guideline base, if no earlier information about the framework is accessible or even to improve a physically characterized rule base. NEFCON has two variations: NEFPROX (for work estimate) and NEFCLASS (for grouping undertakings).

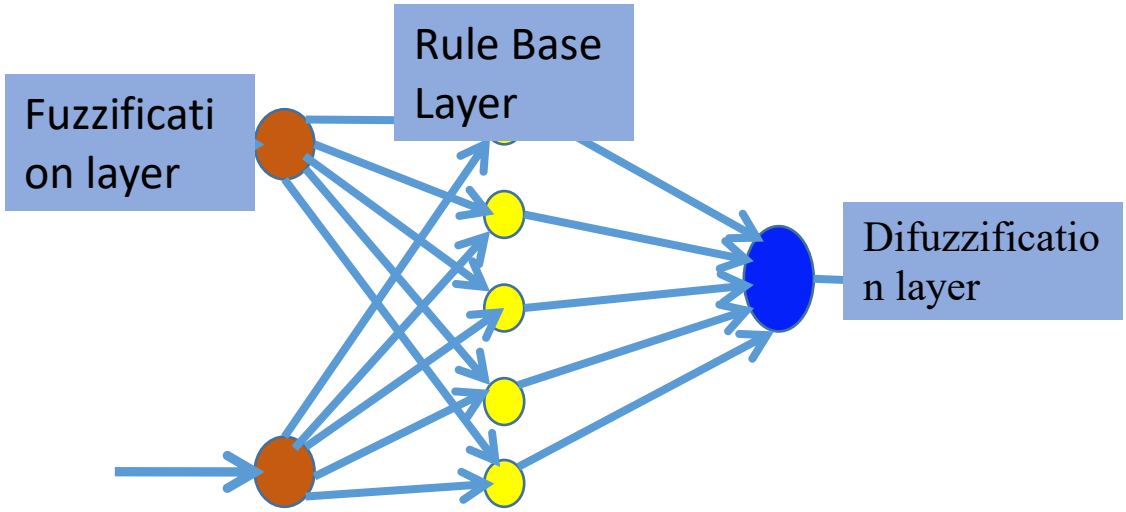

Figure 4: Architecture of NEFCON.

3.4) Neuro-Genetic Technique

The Neuro-Genetic model is a half and half model which shows the qualities of both ANN and GA. It very well may be utilized as the device for dynamic so as to take care of the complex nonlinear issues. In this technique first we characterize a system structure with a fixed number of sources of info, shrouded hubs and yields. Second we utilized the GA in the learning period of the system, as it is skilled to look in a huge inquiry space. The hybridization of ANN and GA, appeared in figure 5 can choose the ideal weight sets just as the inclination esteem for forecast.

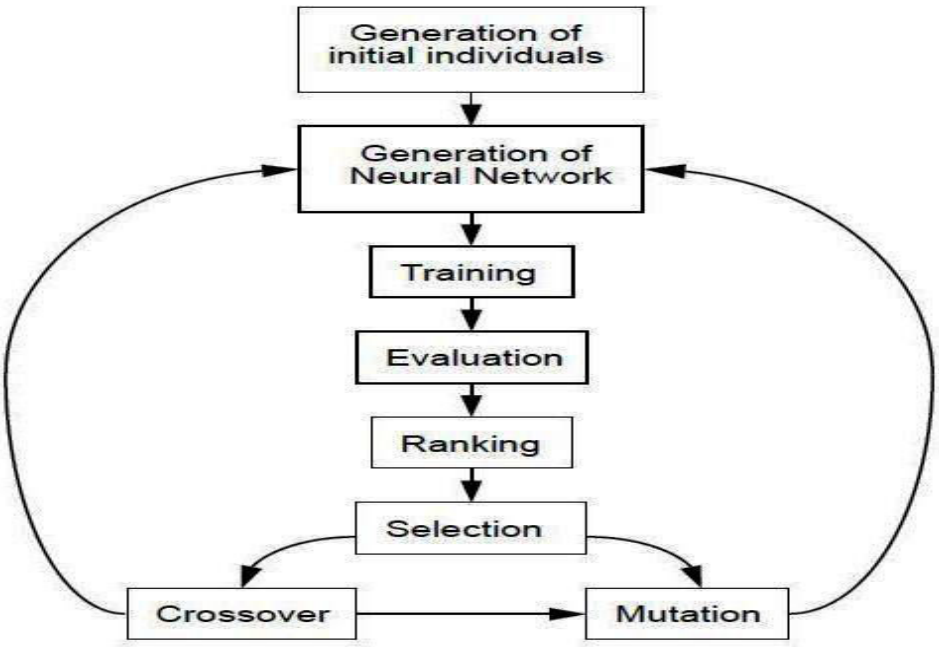

Figure 5: Architecture of Neuro-Genetic Model.

Conclusion

The Proposed classification of extracted images can be a very important method for the diagnosis. Programmed clinical picture characterization is a procedure for relegating a clinical picture to a class among various picture classifications. The propose a Hybrid medical image data classification technique to detect problems with more accuracy. The hybrid method improves the efficiency compared to the traditional image classification methods.

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