

# Red Tide Algae Classification Using Artificial Neural Network

Ms. Nidhi S. Rangari and Dr. V.L Agrawal

<sup>1</sup> Student, <sup>2</sup> Professor

<sup>1,2</sup> Electronic and Telecommunication of HVPM'S

College of Engineering and Technology (India)

**Abstract—** A "red tide" is a typical term utilized for an unsafe algal bloom. A standout amongst the best known HABs in the country happens about each midyear along Florida's Gulf Coast. This bloom, in the same way as other HABs (Harmful Algal blossom), is brought about by infinitesimal red tide algae that produce poisons that murder fish and make shellfish hazardous to eat. With the goal that Red tide, a danger to marine condition, has been a significant issue all around as of late. The species and the number of inhabitants in red tide algae are two key lists to anticipate red tide flare-up. Previously, the assignment to perceive and characterize red tide green growth was attempted by marine environmentalists and taxonomists with magnifying instruments physically, which is tedious and requires considerable pro learning. To beat the restrictions of conventional red tide algal testing instruments, a robotized red tide algae order framework is out of luck. The Efficient classifiers in light of utilizing WHT change with Generalized feed forward (GFF) Neural Network. Another Cross-Validation dataset is utilized for credible examination of the proposed assembling calculation concerning essential execution measures, for example, MSE and solicitation exactness. The Average Classification Accuracy of GFF Neural Network containing one hidden layers with 17 PE's managed in a standard topology supposedly is unrivaled (97.50%) for Training and cross-approval. At long last, flawless tally has been conveyed reliant on the best classifier execution.

**Index Terms—** Neural solution, MatLab, Microsoft excel, all five types of Red Tide Algae SEM images.

## I. INTRODUCTION

Red tides happen normally off coasts everywhere throughout the world. Not every single red tide have poisons or are destructive. Where red tides happen, dead fish appear on shore for as long as about fourteen days after a red tide has experienced the zone. Notwithstanding murdering fish, the lethal green growth debase shellfish. A few mollusks are not helpless to the poison, and store it in their greasy tissues. Shellfish expend the living beings in charge of red tide and concentrate saxitoxin (delivered from these living beings) in their tissues. Saxitoxin squares sodium channels and ingestion can cause loss of motion inside 30 minutes. Different creatures that eat the shellfish are vulnerable to the

neurotoxin, prompting neurotoxic shellfish harming and once in a while even demise. Most mollusks and shellfishes channel feed, which results in higher centralizations of the poison than simply drinking the water. Scaup, for instance, are jumping ducks whose diet basically comprises of mollusks. At the point when scaup eat the channel sustaining shellfish that are concentrated with elevated amounts of the red tide poison, their populace alongside different sorts of plunging ducks become a practical objective for harming. Notwithstanding, even winged animals that don't eat mollusks can be influenced by just eating dead fish on the shoreline or drinking the water, as in the Peking duck analyze. The poisons discharged by the blossoms can execute marine creatures including dolphins, ocean turtles, flying creatures, and manatees. Marine dinoflagellates produce ichthyotoxins. Fish, for example, Atlantic herring, American pollock, winter wallow, Atlantic salmon, and cod were dosed orally with these poisons in a test. Close to accepting dosages of the poison, fish began to display lost balance and started to swim in an unpredictable, snapping design pursued by loss of motion and shallow, arrhythmic breathing and in the long run passing after about 60 minutes. Researchers reasoned that the dangerous red tide effectsly affected fish that were presented to it. People are influenced by the red tide species by ingesting inappropriately gathered shellfish, taking in aerosolized brevetoxins (for example PbTx or Ptychodiscus poisons) and at times skin contact. The brevetoxins tie to voltage-gated sodium channels, significant structures of cell layers. Restricting outcomes in constant actuation of nerve cells, which meddles with neural transmission prompting medical issues. These poisons are made inside the unicellular life form, or as a metabolic item. The two noteworthy kinds of brevetoxin mixes have comparative however particular spine structures. PbTx-2 is the essential intracellular brevetoxin created by *K. brevis* blossoms. Notwithstanding, after some time, the PbTx-2 brevetoxin can be changed over to PbTx-3 through metabolic changes. Specialists found that PbTx-2 has been the essential intracellular brevetoxin that changes over extra time into PbTx-3. At the point when the cells break, they discharge extracellular brevetoxins into the earth. A portion of those stay in the sea, while different particles get aerosolized. Amid coastal breezes, brevetoxins can wind up aerosolized by air pocket intervened transport, causing respiratory bothering, bronchoconstriction, hacking, and wheezing among different manifestations. On a blustery day, staying away from contact with the aerosolized poison is prescribed. These people report a decline in respiratory

capacity after just 1 hour of introduction to a *K. brevis* red-tide shoreline and these side effects may keep going for quite a long time. Individuals with serious or determined respiratory conditions, (for example, unending lung ailment or asthma) may encounter more grounded antagonistic responses. The National Oceanic and Atmospheric Administration's National Ocean Service gives an open conditions report recognizing conceivable respiratory bothering impacts in regions influenced by red tides. Much of the time like in the U.S., the fish devoured by people is tried routinely for poisons by the USDA to guarantee safe utilization. Be that as it may, ill-advised reaping of shellfish can cause incapacitated shellfish harming and neurotoxic shellfish Poisoning in people. A few indications incorporate laziness, looseness of the bowels, sickness, loss of engine control, shivering, desensitizing or throbbing of furthest points, disjointedness, and respiratory loss of motion. In conclusion, reports of skin aggravation in the wake of swimming in the sea amid a red tide are normal, so individuals should endeavor to maintain a strategic distance from the red tide when it is in the zone. Red tide is a conversational term used to allude to one of an assortment of common wonders known as hurtful algal sprouts.

The term specifically refers to blooms of a species of dinoflagellate. It is being phased out among researchers because:

1. Red tides are not necessarily red and many have no discoloration at all.
2. They are unrelated to movements of the tides.
3. The term is imprecisely used to refer to a wide variety of algal species that are known as bloom-formers.

As a technical term, it is being replaced in favour of more precise terminology, including the generic term "harmful algal bloom" for harmful species, and "algal bloom" for benign species.

Destructive algal sprouts, or HABs, happen when settlements of green growth—basic plants that live in the ocean and freshwater—develop wild while creating dangerous or unsafe consequences for individuals, fish, shellfish, marine warm blooded creatures, and feathered creatures. The human diseases brought about by HABs, however uncommon, can be crippling or even deadly.

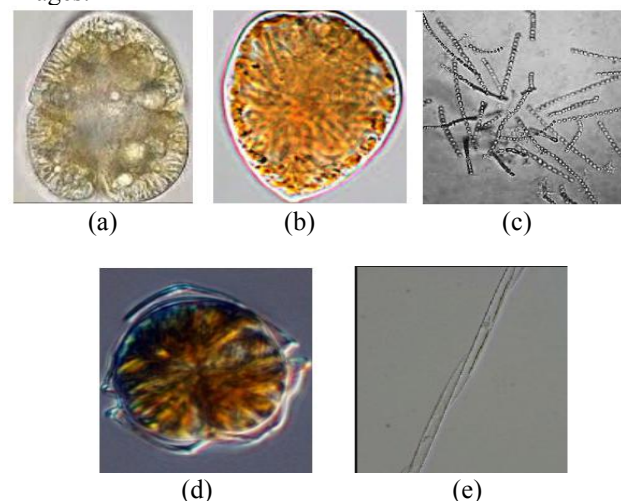
While numerous individuals call these blossoms 'red tides,' researchers incline toward the term hurtful algal sprout. A standout amongst the best known HABs in the country happens about each mid year along Florida's Gulf Coast. This sprout, in the same way as other HABs, is brought about by infinitesimal green growth that produce poisons that slaughter fish and make shellfish hazardous to eat. The poisons may likewise make the encompassing air hard to relax. As the name recommends, the blossom of green growth regularly turns the water red.

HABs have been accounted for in each U.S. seaside state, and their event might be on the ascent. HABs are a national concern since they influence not just the wellbeing of individuals and marine biological systems, yet additionally the 'wellbeing' of neighborhood and provincial economies.

In any case, not every algal blossom are unsafe. Most blossoms, truth be told, are valuable in light of the fact that the small plants are sustenance for creatures in the sea. Indeed,

they are the real wellspring of vitality that energizes the sea nourishment web.

A little level of green growth, nonetheless, produce ground-breaking poisons that can slaughter fish, shellfish, well evolved creatures, and winged animals, and may straightforwardly or in a roundabout way cause disease in individuals. HABs additionally incorporate sprouts of non-dangerous species that effectsly affect marine environments. For instance, when masses of green growth kick the bucket and disintegrate, the rotting procedure can drain oxygen in the water, making the water become so low in oxygen that creatures either leave the zone or pass on. Researchers at the National Ocean Service have been checking and concentrating this marvel for various years to decide how to identify and figure the area of the blossoms. The objective is to give networks preemptive guidances so they can satisfactorily get ready for and manage the unfriendly ecological and wellbeing impacts related with these 'red-tide' occasions. Red tides are brought about by an unstable development and gathering of certain minute green growth, dominantly dinoflagellates, in beach front waters. A few types of dinoflagellates produce poisons that are among the most intense known to man. These destructive green growth sprouts, or HABs for short, represent a genuine and repeating danger to human wellbeing, untamed life, marine biological systems, fisheries, beach front feel and our economy. The most inconvenient species in the Gulf of Mexico is *Karenia brevis*. Like different dinoflagellates these minor, single-celled living beings photosynthesize utilizing chlorophyll like a plant yet they are portable with the utilization of two flagella that push them through the water segment. The algal images utilized in our proposed work were taken by the continuous green growth imaging framework from a flood of water siphoned legitimately from the sea. The majority of the examples were marked by biologic specialists heretofore. Fig. 1 shows certain of the images.



**Figure 1** a)gymnodinium sanguineum, b)prorocentrum micans, c)skeletonema costatum, d)alexandrium costatum, and e) pseudo-nitzschia pun gens

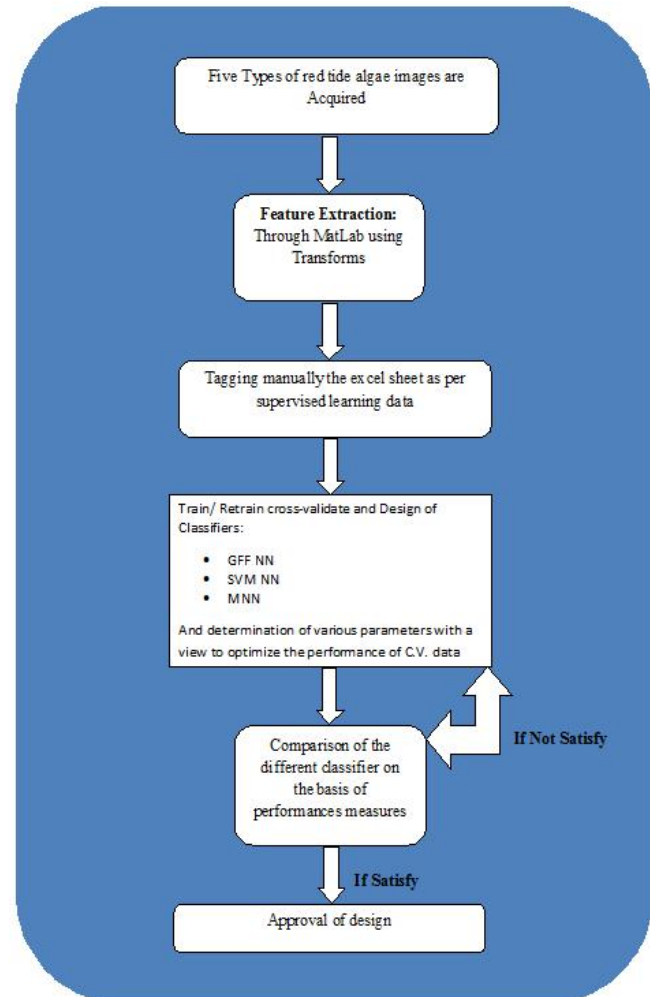
### 1.1 Factors that may contribute to a bloom

Red tides contain thick groupings of creatures and show up as stained water, frequently rosy darker in shading. It is a characteristic marvel, however the careful reason or mix of elements that outcome in a red tide flare-up are not really known. Be that as it may, three key variables are thought to

assume a significant job in a blossom - saltiness, temperature, and wind. Red tides cause monetary damage, so episodes are deliberately observed. For instance, the Florida Fish and Wildlife Conservation Commission gives a modern status report on red tides in Florida. The Texas Parks and Wildlife Department additionally gives a status report. While no specific reason for red tides has been discovered, a wide range of components can add to their essence. These components can incorporate water contamination, which begins from sources, for example, human sewage and horticultural overflow. There are different variables that have been related with the expansion in red tides, for example, climate, environmental change, and tidal examples, despite the fact that the connection isn't in every case very clear. Red tide algal sprouts will in general be increasingly visit amid the mid year in light of the warm temperatures. The event of red tides in certain areas has all the earmarks of being completely characteristic (algal sprouts are an occasional event coming about because of waterfront upwelling, a characteristic consequence of the development of certain sea flows) while in others they give off an impression of being an aftereffect of expanded supplement contamination from human exercises. The development of marine phytoplankton is commonly constrained by the accessibility of nitrates and phosphates, which can be copious in agrarian run-off just as seaside upwelling zones. Waterfront water contamination delivered by people and orderly increment in seawater temperature have likewise been ensnared as contributing components in red tides. Different factors, for example, iron-rich residue convergence from enormous desert territories, for example, the Sahara Desert are thought to assume a noteworthy job in causing red tides. Some algal blossoms on the Pacific Coast have additionally been connected to events of huge scale climatic motions, for example, El Niño occasions. While red tides in the Gulf of Mexico have been happening since the season of early travelers, for example, Cabeza de Vaca, what starts these sprouts and how enormous a job anthropogenic and normal components play in their advancement is misty. Regardless of whether the obvious increment in recurrence and seriousness of algal sprouts in different pieces of the world is in truth a genuine increment or is because of expanded perception exertion and advances in species distinguishing proof techniques is additionally discussed. While the human commitment to the long haul increment in red tides is obvious, a few specialists suggest that environmental change is additionally a factor, with more research still expected to guarantee it as an authoritative reason. Expanding temperature, improved surface stratification, adjustment of sea flows, strengthening or debilitating of nearby supplement upwelling, incitement of photosynthesis by raised CO<sub>2</sub>, decreased calcification through sea fermentation, and substantial precipitation and tempest occasions causing changes in land overflow and micronutrient accessibility may all create opposing species-or even strain-explicit reactions. As far as unsafe algal sprouts (HABs), we can anticipate: (I) go development of warm-water species to the detriment of cold-water species, which are driven poleward; (ii) species-explicit changes in the plenitude and occasional window of development of HAB taxa; (iii) prior planning of pinnacle generation of some phytoplankton; and (iv) auxiliary impacts for marine nourishment networks,

prominently when singular zooplankton and fish nibblers are differentially affected by environmental change. In any case, the potential outcomes of these progressions for HABs have gotten generally little consideration and are not surely known. Generous research is expected to assess the immediate and roundabout relationship between HABs, environmental change, sea fermentation, and human wellbeing.

## II. RESEARCH METHODOLOGY



**Figure.2** Methodology of work

It is proposed to consider the gathering of five kind of Red Tide Algae SEM images Using Neural Network Approaches.. Data verifying for the GFF classifier proposed for the Recognition of five sort of Red Tide Algae SEM pictures. .The most indispensable un compared incorporates and likewise coefficient from the images will be removed . In order to extract features, statistical techniques, image processing techniques, WHT transformed domain will be used.

### 2.2 Neural Networks

**Following Neural Networks are tested:**

#### Feed-Forward Neural Networks

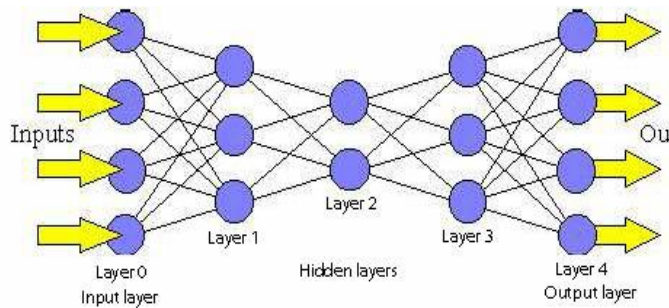


Figure 2.1. A feed-forward network.

Feed-forward networks have the following characteristics:

1. Perceptrons are arranged in layers, with the first layer taking in inputs and the last layer producing outputs. The middle layers have no connection with the external world, and hence are called hidden layers.
2. Each perceptron in one layer is connected to every perceptron on the next layer. Hence information is constantly "fed forward" from one layer to the next., and this explains why these networks are called feed-forward networks.
3. There is no connection among perceptrons in the same layer.

A single perceptron can classify points into two regions that are linearly separable. Now let us extend the discussion into the separation of points into two regions that are not linearly separable. Consider the following network:

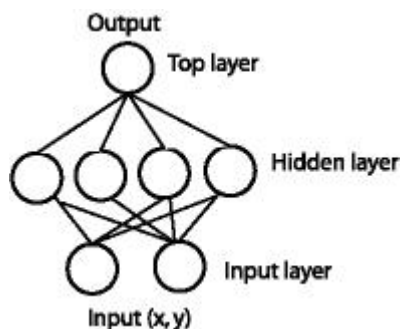


Figure 2.2. A feed-forward network with one hidden layer.

The same  $(x, y)$  is fed into the network through the perceptrons in the input layer. With four perceptrons that are independent of each other in the hidden layer, the point is classified into 4 pairs of linearly separable regions, each of which has a unique line separating the region.

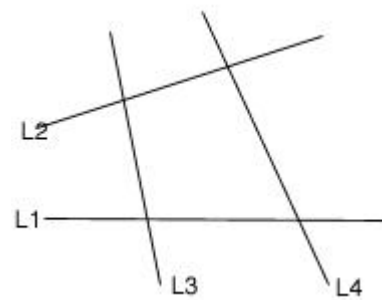


Figure.2.3 lines each dividing the plane into 2 linearly separable regions.

The top perceptron performs logical operations on the outputs of the hidden layers so that the whole network classifies input points in 2 regions that might not be linearly separable. For instance, using the AND operator on these four outputs, one gets the intersection of the 4 regions that forms the center region.

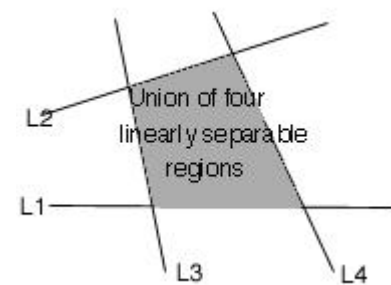


Figure .2.4 Intersection of 4 linearly separable regions forms the center region.

By varying the number of nodes in the hidden layer, the number of layers, and the number of input and output nodes, one can classification of points in arbitrary dimension into an arbitrary number of groups. Hence feed-forward networks are commonly used for classification.

### 2.3 Learning Rules used:

#### ➤ Momentum

Momentum simply adds a fraction  $m$  of the previous weight update to the current one. The momentum parameter is used to prevent the system from converging to a local minimum or saddle point. A high momentum parameter can also help to increase the speed of convergence of the system. However, setting the momentum parameter too high can create a risk of overshooting the minimum, which can cause the system to become unstable. A momentum coefficient that is too low cannot reliably avoid local minima, and can also slow down the training of the system.

#### ➤ Conjugate Gradient

CG is the most prevalent iterative technique for unraveling vast frameworks of direct conditions. CG is successful for frameworks of the shape  $A=xb-A$  (1) where  $x$  is an obscure vector,  $b$  is a known vector, and  $A$  is a known, square, symmetric, positive-unmistakable (or positive-uncertain) lattice. (Try not to stress in the event that you've overlooked what "positive-distinct" implies; we will survey it.) These

frameworks emerge in numerous imperative settings, for example, limited contrast and limited component techniques for fathoming incomplete differential conditions, auxiliary examination, circuit investigation, and math homework.

Created by Widrow and Hoff, the delta govern, additionally called the Least Mean Square (LMS) strategy, is a standout amongst the most usually utilized learning rules. For a given information vector, the yield vector is contrasted with the right answer. In the event that the thing that matters is zero, no learning happens; generally, the weights are changed in accordance with lessen this distinction. The adjustment in weight from  $u_i$  to  $u_j$  is given by:  $dw_{ij} = r * a_i * e_j$ , where  $r$  is the learning rate,  $a_i$  speaks to the initiation of  $u_i$  and  $e_j$  is the distinction between the normal yield and the genuine yield of  $u_j$ . On the off chance that the arrangement of information designs shape a directly autonomous set then subjective affiliations can be gotten the hang of utilizing the delta run the show.

It has been demonstrated that for systems with direct initiation capacities and with no shrouded units (concealed units are found in systems with in excess of two layers), the blunder squared versus the weight chart is a paraboloid in  $n$ -space. Since the proportionality steady is negative, the chart of such a capacity is inward upward and has a base esteem. The vertex of this paraboloid speaks to the point where the mistake is limited. The weight vector relating to this point is then the perfect weight vector..

#### ➤ Quick propagation

Quick propagation (Quickprop) [1] is one of the most effective and widely used adaptive learning rules. There is only one global parameter making a significant contribution to the result, the  $e$ -parameter. Quick-propagation uses a set of heuristics to optimise Back-propagation, the condition where  $e$  is used is when the sign for the current slope and previous slope for the weight is the same.

#### ➤ Delta by Delta

Created by Widrow and Hoff, the delta manage, likewise called the Least Mean Square (LMS) technique, is a standout amongst the most regularly utilized learning rules. For a given information vector, the yield vector is contrasted with the right answer. In the event that the thing that matters is zero, no learning happens; generally, the weights are changed in accordance with diminish this distinction. The adjustment in weight from  $u_i$  to  $u_j$  is given by:  $dw_{ij} = r * a_i * e_j$ , where  $r$  is the learning rate,  $a_i$  speaks to the initiation of  $u_i$  and  $e_j$  is the distinction between the normal yield and the genuine yield of  $u_j$ . In the event that the arrangement of info designs shape a directly free set then discretionary affiliations can be gotten the hang of utilizing the delta run the show.

It has been demonstrated that for systems with direct actuation capacities and with no shrouded units (concealed units are found in systems with in excess of two layers), the blunder squared versus the weight chart is a paraboloid in  $n$ -space. Since the proportionality steady is negative, the diagram of such a capacity is inward upward and has a base esteem. The vertex of this paraboloid speaks to the point where the mistake is limited. The weight vector relating to this point is then the perfect weight vector. [10]

### III. RESULT

The GFF neural system has been reproduced for 154 distinct Red tide algae SEM Images out of which 139 were utilized for training and 15 were utilized for cross validation.

The simulation of the Best Neural network with maximum accuracy is shown below:

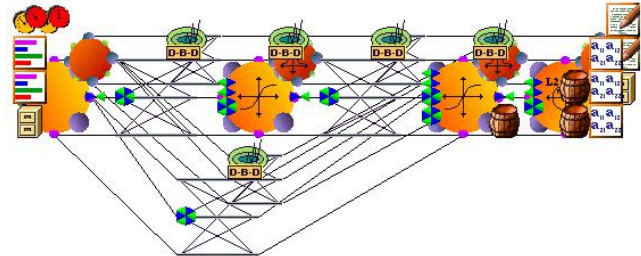


Figure4. The Best Neural network with maximum accuracy (GFF-DBD)

Training Report of the Best Classifier:

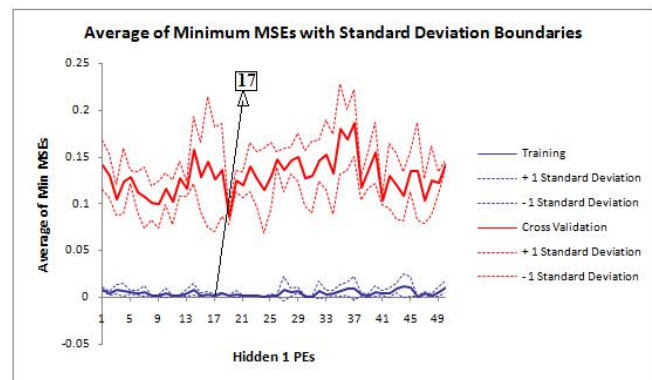


Table 1. Training and cross validation Report of the Best Classifier GFF-DBD

Best Networks	Training	Cross Validation
Hidden 1 PEs	31	17
Run #	2	1
Epoch #	350	180
Minimum MSE	0.000624261	0.064117603
Final MSE	0.184678637	0.064647924

Test on Cross validation (CV):

Table 2. Confusion matrix table of Cross validation (CV)

Output / Desired	NAME(SKELETO NEMA COSTATUM)	NAME(PSEUDO NITZSCHIA PUN GENS)	NAME(PROROCE NTRUM MICANS)	NAME(GYMNOD INIUM SANGNINEUM)	NAME(ALEXAND RIUM COSTATUM)
NAME(SKELETO NEMA COSTATUM)	2	0	0	0	0
NAME(PSEUDO NITZSCHIA PUN GENS)	0	3	0	0	0
NAME(PROROCE NTRUM MICANS)	0	0	5	0	0
NAME(GYMNOD INIUM SANGNINEUM)	0	0	0	4	0
NAME(ALEXAND RIUM COSTATUM)	0	1	0	0	3

Table 3: Performance Measures for cross validation

Performance	NAME(SKELETO NEMA COSTATUM)	NAME(PSEUDO NITZSCHIA PUN GENS)	NAME(PROROCE NTRUM MICANS)	NAME(GYMNOD DINIUM SANGNINEUM)	NAME(ALEXAND RIUM COSTATUM)
MSE	0.003608632	0.098365182	0.078044684	0.007683086	0.035729521
NMSE	0.036537404	0.56911284	0.389022734	0.044452143	0.25725255
MAE	0.049516444	0.205983541	0.16385798	0.059940368	0.125163948
Min Abs Error	0.00923444	0.004773332	0.002675184	0.003378718	0.002368831
Max Abs Error	0.122122324	0.772376226	0.778892998	0.248915846	0.547836762
r	0.982798332	0.666996593	0.799514303	0.978986586	0.866573814
Percent Correct	100	75	100	100	100

Test on Training:

Table 6: Confusion matrix table of Training

Output / Desired	NAME(SKELETO NEMA COSTATUM)	NAME(PSEUDO NITZSCHIA PUN GENS)	NAME(PROROCE NTRUM MICANS)	NAME(GYMNOD INIUM SANGNINEUM)	NAME(ALEXAND RIUM COSTATUM)
NAME(SKELETO NEMA COSTATUM)	10	0	0	0	0
NAME(PSEUDO NITZSCHIA PUN GENS)	0	28	0	0	0
NAME(PROROCE NTRUM MICANS)	0	0	39	0	0
NAME(GYMNOD INIUM SANGNINEUM)	0	0	0	32	0
NAME(ALEXAND RIUM COSTATUM)	0	0	0	0	25

Table 7: Performance Measures for training

Performance	NAME(SKELETO NEMA COSTATUM)	NAME(PSEUDO NITZSCHIA PUN GENS)	NAME(PROROCE NTRUM MICANS)	NAME(GYMNOD DINIUM SANGNINEUM)	NAME(ALEXAND RIUM COSTATUM)
MSE	0.000923733	0.001582397	0.001375825	0.02224245	0.002906766
NMSE	0.013376253	0.00957329	0.006667829	0.122260586	0.019153723
MAE	0.025880848	0.030585979	0.030510487	0.088070965	0.042234134
Min Abs Error	0.000341181	0.001500277	0.00122026	0.00063591	0.001786679
Max Abs Error	0.054931011	0.23717989	0.127070512	0.677001448	0.254452379
r	0.995366211	0.995420076	0.997382783	0.944551626	0.994002507
Percent Correct	100	100	100	100	100

#### IV. CONCLUSION

A From the results obtained in WHT domain it concludes that the GFF Neural Network with DBD (delta bar delta) and hidden layer 1 with processing element 17 gives best results of 95% in Cross Validation while in training it gives 100% so overall accuracy is 97.50%.

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