



# A Review of Computational Intelligence Techniques for Rainfall Prediction

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## Abstract

Rainfall Prediction is viewed as one among the difficult stages in Anticipating Climate. There are many benefits of exact and opportune expectation of Rainfall. It helps in taking preventive measure against farming troubles, flood circumstances and so on. The fields like horticulture, oceanic life, and biological system get impacted of it. To get the genuine Rainfall data, different measurable strategies are proposed in the writing. Because of dynamic nature of climate, factual procedures neglect to give great precision to Rainfall determining. Nonlinearity of Rainfall information makes Counterfeit Brain Organization an improved procedure. Survey work and examination of various methodologies and calculations involved by analysts for Rainfall Prediction are dissected in this paper. The fundamental point of this paper is to give non-specialists a simple admittance to the computational knowledge methods and approaches utilized in the field of Rainfall forecast.

**Keywords**-Rainfall Prediction, Neural Network, Computational Intelligence Model, Expert System, MLP.

**DOI Number:** 10.14704/nq.2022.20.11.NQ66113

**NeuroQuantology 2022; 20(11): 1182-1191**

## Introduction

Rainfall assume significant part in framing of fauna and verdure of normal life. It isn't only huge for the individuals yet in addition for creatures, plants and every living thing. It assumes a huge part in horticulture and cultivating and without a doubt; water is quite possibly of the most normal asset on the planet. The changing climatic circumstances and the rising nursery emanations have made it hard for the people and the planet earth to encounter the vital measure of Rainfall that is expected to fulfill the human necessities and its continuous use in day to day existence. In this way, it has become important to dissect the changing examples of the Rainfall and attempt to anticipate the downpour for the human requirements as well as to anticipate for catastrophic events that could cause by the

surprising weighty rainfalls. More specifically and mindful of the overwhelming climatic changing and remain refreshed; foreseeing Rainfall has been the focal point of PC researcher and specialists.

Rainfall is a characteristic peculiarity. Rainfall Prediction is viewed as a difficult undertaking in meteorology. It has prime significance in the areas like science and exploration, sea life science and so forth. Rainfall Prediction is hard to proceed as well as a difficult errand. One of the excellent purposes behind it is the powerful changes in environment and climatic cycle. Hence exactness in Anticipating Rainfall is the significant test for Meteorology Division [1]. Exact Forecast of Rainfall is preposterous as it can't be anticipated where the Rainfall will happen and regardless of whether it is a weighty Rainfall. The normal elements, which



influence the event of Rainfall, are temperature, stickiness, wind speed, movement of cloud and so on. It helps in saving life and resources and does debacle the board caused because of weighty Rainfall. In this way to give a precise expectation, a bunch of forecast models have been formulated and carried out. This Paper has the objectivity of going through different models connecting with computational insight. Numerous Scientists have applied a bunch of strategies for Rainfall Prediction and had a go at fostering specific mechanically progressed observing Framework by carrying out and coordinating Counterfeit Brain Organization, Hereditary Calculation [2].MLP likewise helps in expectations, Hereditary Calculation is applied for inputs, structure between the data sources, the result layers and to make the preparation of Brain Organization more powerful [3].

### **Introduction to rainfall**

Rainfall is one the main climatic event that isn't just helpful for the actual climate however for every one of the living creatures on the earth. It influences everything straightforwardly or in a roundabout way and on the grounds that it is perhaps of the main regular peculiarity; the people must contemplate on the Rainfall changes with the adjustment of environment. The Rainfall altogether affects the all inclusive check of barometrical dissemination and it influences the neighborhood atmospheric conditions also. The Rainfall helps in adjusting the rising temperature and in the endurance of the people. The rising temperature of the world is related with the a dangerous atmospheric deviation and the water is one of the scant and most valuable assets which in the consequence of this rising temperature are dissipating from the stores. Rainfall is likewise pay to this multitude of stores and it is essential for the

farming and its creation too. The peculiarity of Rainfall contrasts with the distinction in scope and longitude. The Rainfall peculiarity likewise varies with the distinction of districts, planes, uneven and levels. Rainfall happens as strati structure or convective downpour; the high scope regions experience strati structure downpour which is a seriously predominant type of the downpour. These regions incorporate the tropical and subtropical and they experience half to 80% of strati structure downpour Rainfall. It is essential to gauge the circulation of the Rainfall on the worldwide level and for that as of now the remote satellite detecting methods are helping with estimating the appropriation of the downpour on the worldwide level. Exceptional Sensor Microwave Imager (SSM/I) locally available with the US Guard Metrological Satellite Program (DMSP) are utilized for get-together the data about the Rainfall with other space-borne instruments like microwave instrument, flying on board the US - Japanese Tropical Rainfall Estimating Mission (TRMM) and Rainfall radar (PR) that work on various frequencies and are aiding the information assortment and in getting the impressions precisely.

### **Types of rain**

#### **1. Conventional Rainfall**

The critical and the most prevailing type of the Rainfall is the convectional Rainfall. It is knowledgeable about the high scope regions like the tropical and the subtropical. It is typically seen with lightning and tempest. The regular Rainfall is a sort of Rainfall that is impacted by the mountains and the bumpy districts; as it is the most prevailing type of Rainfall and it relies upon the scope.

#### **2. Orographic Rainfall**



The orographic downpour is the type of Rainfall that is shaped by the damp air which normally can be seen over the mountains. The clammy air over the mountains is dissipated or lifted vertical heading. At the point when the damp air is lifted and ascends to a specific level it chills off; the orographic mists are framed and afterward gathers and structures the Rainfall. The orographic Rainfall is shaped by the huge number terrains like the one with enormous mountains (Dim and Seed, 2006). The orographic Rainfall has little water drops that are consolidated.

### 3. Cyclonic or front facing Rainfall

The cyclonic or the front facing Rainfall is the last and third kind of the Rainfall. The cyclonic by name addresses the tempesting and happens when the air masses with unmistakable qualities slam into each other. The impact of light air that is warm and the virus air that is weighty happens; the virus air energizes the warm air since it is lighter to rise. The rising air chills off by shaping the water fumes.

## Measurement of rainfall

### 1. Ordinary downpour Measure

The customary downpour check estimation is a less compelling and less exact strategy of estimating the Rainfall. It has been seen that the customary check is the non-programmed perception and utilizations a glass to quantify the downpour at standard stretches. It has a shell, a capacity bottle with a capacity vessel and a glass for estimating the downpour.

### 2. Self-recording Rainfall Check

The regular self-recording Rainfall check is more productive and more compelling in estimating the downpour than that of the normal measure for the estimation of downpour. The conventional technique for recording Rainfall is wasteful and gives off base outcomes as it's

done physically so it can include human mistakes (Facial hair, 1962). Oneself recording Rainfall check is seen to involve basic procedure and instruments to deliver better estimations to have better likelihood and precision.

### 3. Zonal conveyance of downpour

The examples of the Rainfall are not steady; it changes season to season and area to area. There are sure various zones that get more Rainfall than not many of them getting less Rainfall. The Rainfall of the Rainfall as a mean worldwide conveyance contemplated to be impacted by the latitudinal zones, land and ocean surfaces and Rainfall. The East Asian area Rainfall including China, Korea and Japan assesses that storm begins from mid-finish of May to the furthest limit of July for China and September in the event that if Korea.

## Literature Study of Rainfall Prediction Methods

Luk et al. (2001) examined three kinds of ANNs for Rainfall estimating. Multi-facet Feed Forward Brain Organization (MLFN), Elman incomplete intermittent brain organization and Time-Postpone Brain Organization (TDNN) execution were thought about with respect to mistake rate. The exploratory outcomes revealed the above frameworks may maybe make a satisfactory Rainfall conjecture. Thusly, the quantity of secret hubs brought about the ideal intricacy and time postponement of the organization. The proposed brain network structures had similar execution and prepared to arrive at their ideal intricacies when they were created.

Solomatine (2003) gave a gap and vanquish approach where the total locale is partitioned into four sub-regions and each is demonstrated with an alternate technique. For two bigger regions, they have utilized outspread premise capability (RBF) organizations to perform Rainfall Prediction. The other two more modest



sub-regions, they have utilized a straightforward direct relapse model to foresee the Rainfall. The two methods have practically comparable execution for 1-h ahead expectation of overflow, butte aftereffect of the ANN is somewhat better compared to the Model Tree for higher lead times.

Philip and Joseph (2003) saw that despite the fact that Rainfall is unusual, it shows specific periodicity when observed over a long period. ANNs were utilized to comprehend the periodicity in the Rainfall design. Hence, they gathered an informational collection containing month to month Rainfall information recorded at Trivandram, Kerala for the period 1893 to 1933. Srikalra and Tanprasert (2006) detailed a concentrate on everyday Rainfall Prediction with brain networks utilizing Rainfall informational collection of each downpour check station around Chao Phraya Stream (Thailand) for a period from 2002 to 2005. Back engendering brain network was utilized for preparing and testing the gauge model. The typical precision of the preparation set and testing set was accounted for as 97.42% and 95.44% separately. The outcomes communicated, the potential outcomes of anticipating the Rainfall utilizing ANN on regular routine with huge exactness. They likewise suggest the utilization of extra information sources like temperature and mugginess for better execution of the models.

Kumar et al. (2007) revealed the utilization of Back engendering ANNs with Steepest angle procedures for anticipating the occasional and month to month Rainfall and execution of occasional Rainfall models were accounted for to be better on correlation with the month to month expectation models'. Guhathakurta (2008) revealed a deterministic brain network model for month to month Rainfall time series information utilizing the back-engendering

learning calculation. The exhibitions of this model were empowering.

Nasseri et al. (2008) utilized an ANN model with Back spread calculation coordinated with the Hereditary calculation to foresee Rainfall in Australia. The creator notices MLP type network combined with GA, reliably performed better compared to MLP network alone. Deface and Naing (2008) introduced ANN to conjecture the absolute month to month Rainfall in Yangon, Myanmar. This examination was completed for the period 1970 - 2006 as info. They revealed that the exhibition of the brain network model is palatable, and doable for Rainfall estimate model in Myanmar locales. Hung et al. (2009) revealed an ANN procedure for further developing Rainfall estimate execution in Bangkok situated in Thailand utilizing four years of hourly information gathered from 75 downpour check stations. It was applied to the ongoing Rainfall estimating and flood the executives. They revealed a summed up feed-forward ANN model utilizing exaggerated digression move capability and the utilization of a reasonable blend of meteorological boundaries allowed the model to settle estimating issues at any moment of time.

Rainfall Prediction assumes a significant part in the cultivation, agribusiness, water asset the board, crop creation plan. This expectation plays an essential part in serving to the humankind. The specialists anticipate Rainfall with precision with the assistance of various number of approaches. Barely any techniques are precise than the others [4]. Climate Forecast is a technique, which gets information basing on barometrical circumstances. It records the different environment boundaries like dampness, temperature, wind speed, Rainfall, bearing, etc. Different number of apparatuses can be utilized for getting the information gauging the climate. Those devices might be remote sensors, radars, fast PC frameworks,



meteorological satellites and so forth [5]. Weather conditions estimate has various benefits, such as checking and noticing environment or climate, conquering environment risks, horticulture creation, location of dry season, flight industry, etc. As a general rule, a lot of climate information are accessible with various sources like meteorology division site, UCI, Kaggle Stores and so on. These are considered as rich data and used for expectation. Various Information Mining Strategies are utilized with accessible climate information for anticipating air boundaries. These boundaries referred to above are dynamic in nature [6]. Climate estimation with environment boundaries change with the topographical area. Following are the Information Mining Procedures, utilized for climate expectation

#### **Back Propagation Network (BPN)**

The back-spread learning calculation is quite possibly of the main advancement in brain networks [2]. This organizations still the most well known and best model for complex, diverse organizations. This learning calculation is applied to multi-facet feed-forward networks comprising of handling components with constant differentiable enactment capabilities. The organizations related with back-engendering learning calculation are additionally gotten back to spread organizations (BPNs). It is a directed learning technique. For a given arrangement of preparing input-yield pair, this calculation gives a strategy to changing the loads in a BPN to accurately group the given information designs. The fundamental idea of this calculation is, it comprises of two goes through the various layers of the organization: a forward pass and a regressive pass. In the forward pass, an information vectors applied to the tangible hubs of the organization and its impact proliferates through the organization layer by layer. At last a bunch of results

delivered as the genuine reaction of the organization. During the forward pass the synaptic loads of the organizations are totally fixed. During the retrogressive pass, then again, the synaptic loads are completely changed as per a mistake revision rule. In particular, the genuine reaction of the organization is deducted from the ideal (target) reaction to create a mistake signal. This mistake signal is then engendered in reverse through the organization, against the heading of synaptic associations, subsequently the name "blunder back-spread". The synaptic loads are changed in accordance with make the genuine reaction of the organization draw nearer to the ideal reaction from a factual perspective [1]. The run of the mill back-engendering network contains an info layer, a result layer, and no less than one secret layer. The quantity of neurons at each layer and the quantity of secret layers decide the organizations capacity on delivering precise results for a specific informational index. The greater part of the scientists have been involved this organization for Rainfall Prediction.

#### **Radial Basis Function Networks (RBFN)**

RBF Organizations are the class of nonlinear layered feed forward networks. It is an alternate methodology which sees the plan of brain network as a bend fitting issue in a high layered space. The secret units give a bunch of "capabilities" that comprise an inconsistent "premise" for the information designs (vectors) when they are extended to the secret space, these capabilities are called spiral premise capabilities. The development of a RBF network includes three layers with completely various jobs: the info layer, the main secret layer, and the result layer ([3], [4]). When a RBF network is utilized to play out a mind boggling design grouping task, the issue settled by changing it into high layered space in a nonlinear way. RBF networks and MLPs (Multi-facet



Perceptron's) are instances of nonlinear layered feed forward networks. They are both all inclusive approximates. Be that as it may, these two organizations vary from one another. A RBF networks has a solitary secret layer, though a MLP might have at least one secret layers. The secret layer of a RBF network is nonlinear and the result layer is straight, while the covered up and yield layers of amp are generally all nonlinear [1]. A few specialists have involved this organization for exact Rainfall Prediction and came by significant outcomes.

### Fuzzy Logic

Fluffy rationale is known as Fluffy Surmising Framework (FIS).Fuzzy rationale has two parts, Information base and data set. Information base is made out of a bunch of on the off chance that, rules while data set characterizes the enrollment capability. Fluffy Rationale

depends on acknowledgment. Here coherent explanations are taken, however not limited with valid or misleading qualities. It ranges with "practically 100%" worth to "impossible" [7]. Fluffy rationale assumes an essential part in master framework applications. Fluffy derivation framework (FIS) has following blocks,

1. Rule base-It comprises of on the off chance that principles
2. Participation capabilities It utilizes fluffy principles
3. Dynamic Unit-It performs surmising tasks
4. Fuzzification Point of interaction It switches the fresh contributions over completely to levels of coordinate with semantic qualities
5. Defuzzification interface-It changes the fluffy derivation results to fresh result. Following Figure suggests the underlying portrayal of Fluffy Deduction Framework.

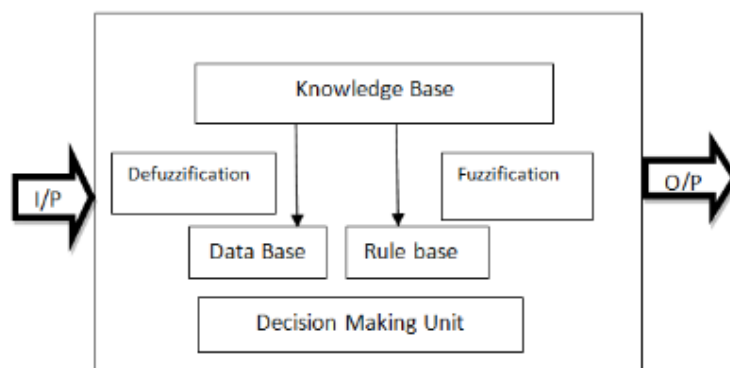


Fig 1-General Structure of FISB.

### Self-Organizing Map (SOM)

Self-Sorting out Guide is an extraordinary class of fake brain organization. These organizations depend on cutthroat learning. The result neurons of organization contend among themselves tube enacted or terminated, with the outcome that only one result neurons is on whenever. This neuron is called winning neuron. The weight vector partner with winning neurons just refreshed in the plan "the champ brings home all the glory". In light of solo

realizing, and that implies that no human mediation is required during the learning and that little should be had some significant awareness of the qualities of information. In Cover neurons are coordinated in a couple of layered cross section. SOM are information perception strategy designed by Prof. TeuvoKohonen that diminishes the elements of information through self-putting together brain organizations. The manner in which SOM approach lessening aspects is by creating a





guide of normally 1-D or 2-Ds, which plot the similitudes of the information by gathering comparative information things together. Thus, SOMs get two things done, they lessen aspects and show likenesses ([1], [5], and [6]).

### ANN (Artificial Neural Network)

Counterfeit Brain Organization (ANN) is a data handling structure. It is surmised from the natural sensory system. Natural Sensory system comprises of cerebrum and handling data [8]. It is comprising of interconnected handling components known as neuron. Its goal is to

tackle some particular issue. ANN is an adaptable number-crunching primary portrayal. It finds basic nonlinear connection among information and result informational collection. Fake Neuron Organization Models are vital. They are additionally productive. The Handling components are associated by brief loads. They adjust through an educational experience [9]. In this time, Counterfeit Brain Organizations have been found with application in vision, design acknowledgment, characterization, discourse acknowledgment, and control frameworks.

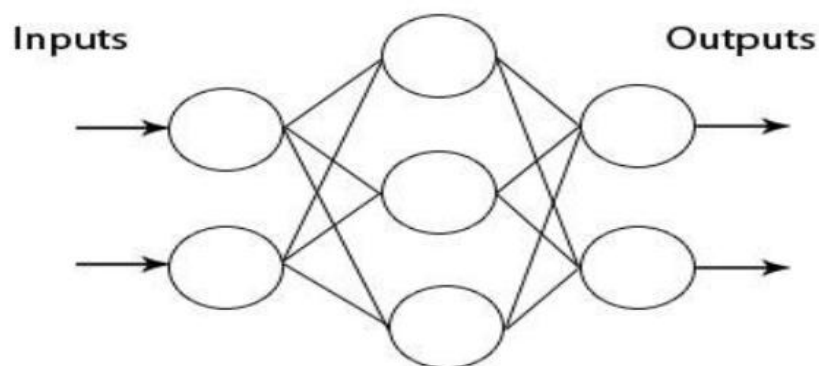


Fig 2-ANN

### Regression

A statistical approach, which tries to get the conclusion of the strength of the relationship between one dependent variable and a series of other independent variables is known as Regression [10]. A Regression Model contains two and more number of predictor variables. These are known as Multiple Regression Model [11].

Dependent variable is taken as Y and independent variable as X.

Multiple regression model is of the following form:

$$Y = a_0 + a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4 + \dots + e$$

Where  $a_0, a_1, a_2, a_3, a_4$  are known as the regression coefficient,  $e$  is the unexplained portion of dependent variable with zero mean along with constant variance [12].

Multiple regression is used as a model to predict a dependent variable from two or more independent variables [12].



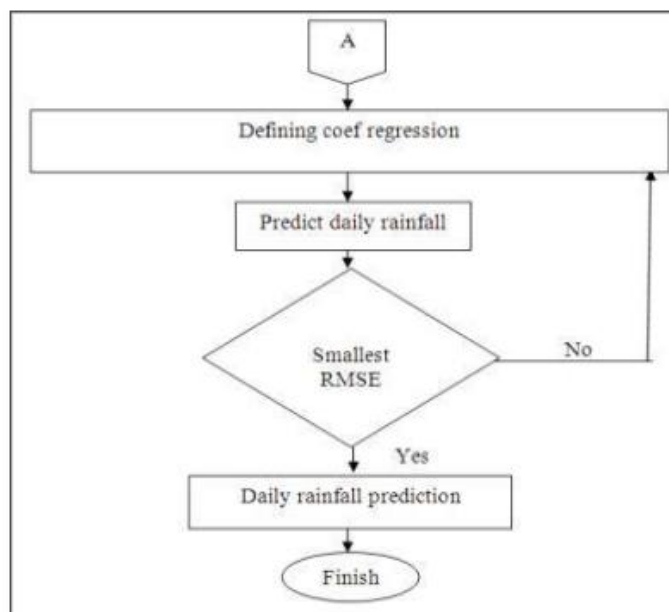


Fig 3: Regression steps

### Naive Bayes

Naive Bayes classifier is a simple approach of Bayesian network. Naive Bayes class has no parents. Single attribute is having parent, which is class. The model is built without counting complex parameters [13]. For large data sets, the classification methods applicable. The approach has explicit model for deployment. It can be applicable for any real world issue. Minimal training data can be used for prediction of classification parameters [14]. The methodology is usually applied to predict rain fall.

### Multilayer Perceptron (MLP)

MLP, which stands for Multi-Layer Perceptron is called Feed Forward Network. It belongs to Artificial Neural Network (ANN). It is composed of nonlinear activation function. This function is present in hidden layer. Input and Output vectors perform nonlinear mapping [15]. There are two functions,

1. Pattern Classifiers
2. Nonlinear Adaptive Filters

The neural network consists of three layer architectures,

1. Input layer defines input value,
2. Hidden layers defines the mathematical function,
3. Output layer defines final outcome of each layer. The set of neurons are interconnected with weights [16]. Neuron has activation function. It takes input with the earlier layer, yields output for the later one. The Activation Function counts the number of Predictions [17].

### Support Vector Machines (SVM)

Support Vector Machine is a multi-facet feed forward network. Support Vector Machines can be utilized for design characterization and nonlinear relapse. Support Vector Machines was created by Vapnik and his associates. Its





application is for directed learning [17]. The justification behind it is better speculation execution contrasted with Brain Organization model. SVM result is interesting, ideal. SVM is a strategy, which tackles various characterization issue, Portion PCA, Part based grouping, include choice, and dimensionality decrease. A specialists have utilized the method to foresee Rainfall to see as exact result. Support Vector Machines (SVM) with straight or nonlinear portions is a learning calculation utilized for the grouping and relapse. These are the techniques in information mining with part planning. SVM is a bunch of regulated learning techniques. SVM is an augmentation to nonlinear models of the calculation [18].

### Decision Tree

One of the prescient demonstrating approaches is Choice Tree. It tends to be utilized in expectation, grouping, and bunching. It utilizes a procedure, Separation and Vanquish, which disintegrates the issue into number of subsets [19]. The Choice Trees comprises of two sections,

1. The development of the tree to empower it to precisely classify the preparation dataset
2. The pruning stage is a system in AI as well as looking through calculation to diminish the size of choice tree. It beats the classifier gives subsequently expanding the prescient precision.

### Conclusion

Nowadays, ANNs are used in various areas of real life according to their characteristic to solve many problems. Prediction or forecasting is a powerful ability that ANNs are characterized by. This ability is effective in serving humanity if it can meet the conditions of realism and accuracy through the obtained results. This paper is planned to give an investigation of a no. of Rainfall forecast techniques utilized by various analysts. It helps producing a forecast model in

getting Rainfall exactness by carrying out any of the methods referred.

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