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Iot based Agriculture Drought Prediction using Chaotic Genetic Algorithm Integrated Intuitionist Fuzzy Subtractive Clustering

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***Abstract:**The exponential demand in usage of internet of Things (IoT) devices, there is a vast effective improvement in commination among different things. Especially in the field of agriculture, IoT based applications plays a vital role to make the functionalities more reliable. With the perception of IoT and wireless sensor network, smart intelligent farming system has become a significant research area for researchers. Several researchers have developed automation and monitoring system for various agricultural functionalities. One of the serious issues is agricultural droughts which affect crop production or the ecology of the range. This research work aims to overwhelm this issue positively by enhancing the agriculture drought prediction in India. This proposed technique enriches the quality of the dataset by finding the similar patterns using chaos genetic algorithm based Intuitionistic fuzzy Subtractive Clustering. The uncertainty in drought prediction is greatly handled by representing the dataset in the form of intuitionistic fuzzy domain which gives more importance to the degree of indeterminacy. Intuitionistic fuzzy inference system is enhanced with the knowledge of subtractive clustering. The cluster centroids are selected by the chaotic genetic algorithm,which overcomes the earlier convergence and increase the search space in a parallel manner to handle voluminous agriculture dataset. Feed forward neural network is used for predicting the clustered agriculture dataset to provide intelligent smart solution for drought prediction and to improve the crop growth monitoring task by farmers.*

***Keywords** :Agriculture drought, IoT, chaos genetic algorithm, intuitionistic fuzzy subtractive clustering, uncertainty.*

I. INTRODUCTION

Since ancient period, agriculture or farming is considered as the foremost culture practiced in India. Increasing of factories and industries leads to global warming and climatic conditions of India is also drastically changed and thus it affects thefarming of agriculture field which is slowly degrading. This arises a need for precision agriculture which acquires the information such as rainfall, temperature, pressure, soil moisture and fertilizer for its decision-making system to increase crop growth by utilizing available resources in an optimal way and without affecting the environment.

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Among several issues related to efficient crop growth maximization, drought prediction is of serious reputation to initial cautionary for drought managements. The most instantaneous significance of agriculture drought is a fall in crop production which is due to poorly distributed and inadequate rainfall.

Thus, sustainable management of water resources becomes defining challenges for farmers.

By considering these issues, nowadays smart intelligent farming has started emerging by the introducing Agricultural IoT. Usage of IoT in agriculture greatly assist the farmers to monitor vital information like air temperature, humidity, air pressure and soil quality using remote sensors and to improve yields, efficient planning of irrigation to overcome the agriculture drought. The crop water management functionalities of Agriculture IoT produces great values in the area of drought. Because it intelligently accomplishes the limited water supply by manipulating the valve operation effectiveness and constructing best irrigation policy, ensuing in improved observes to preserve water resources and drought prediction. The data sensed by sensors are transmitted to the centralized entity for analysis and enhancement. Then analyzed result are communicated to the farm personnel.

This proposed work designed and developed an intelligent Agriculture IoT for drought prediction model using Chaos Genetic Algorithm based Intuitionistic fuzzy subtractive Clustering. This mechanism greatly handles the uncertainty in agriculture dataset for forecasting the drought to avoid downfalls in crop production and to insist usage of water resource management more effectively.

I. RELATEDwORK

Sanjay*etal*[1] developed a back-propagation algorithm weather forecasting system which takes wind speed its direction, temperature and rainfall are considered as input parameters. They used three different models in order to predict the climatic condition. Weather related data is collected by the first model, WSN tool kit is introduced in the second model and the final model applied back-propagation based weather forecasting.Jagielska*et al* [2], introduced fuzzy set and probability theory for predicting the yield of crops. Based on the experience of the farmer and climatic condition the prediction of crop yielding is done. Ramesh D *et al*[3], in their work collected dataset from east Godavari district of AP. The dataset comprised of rainfall, production, area of sowing and year of data recorded are involved for prediction process.

They used Multiple linear regression with K-means clustering to predict the crop yield Veenadhari*et al* [4], in their research of determining productivity of soybean crop. They used decision tree model on dataset about climatic condition in Bhopal District of Madhya Pradesh State.

Rainfall and temperature are used for predicting the paddy crop yield using naïve bayes classification. Wen-Yaw Chung et al [5], introduced an integrated approach by combining WSN and cloud computing in the field of agriculture. The data is collected using sensors which sense the temperature pH value and humidity of the concern agriculture filed. The models inhibit reasonable storage capacities of both hardware and software.

HemlataChanne*et al* [6], proposed Agro Cloud model which stores the details of the farmers, farmlands, e-governance and vendors. In cloud storage the details about the cost of agriculture products are stored. The black bone senor is used to aggregate the environmental and soil properties. Duncan Waga*etal*[7], in their work introduced cloud computing based agriculture process prediction. Private cloud storage is utilized for storing and retrieving dataset. The parameters involved in prediction process are rainfall, winds and temperature. The Hadoop packages is used for simulation process which provides more beneficiary to the farmers.Rao*et al*[8], developed a model based on IOT under cloud paradigm to handle the big data. They introduced a novel prototype model which enhances the agriculture activities and environmental studies. The cloud services and WSN provides reliable improvement in accessibly and scalability of big data analysis in agricultural activities.

Rajesh *et al*[9], proposed an integrated model for industrial processing. The used service-oriented model which integrate and control the sensor nodes. The data is store and made available to the users using cloud computing paradigm. The information collected and stored in cloud are very essential for delivering data for industrial activities.

Though there are several existing works in the field of agriculture activities there is no complete proof for treatment of imprecise, vague and uncertain information in drought prediction. Hence this paper aims at design and development of IoT based agriculture drought prediction with the aid of integrated approach to produce optimal results.

II. PRELIMINARIES

A. About Genetic Algorithm

Genetic Algorithm [10] is a nature inspired algorithm which is developed based on the evolution of genetic and selection of genes. It works on population of individuals termed as chromosomes. During each iteration a new generation is created by genetic operators among selected chromosomes. These chromosomes are encoded in a binary format for computation process. The initial population is selected from a random chromosome which are uniformly distributed over the search space. After that, evaluation process takes place to enroll the individuals of the population. Next, according to the marks scored by the individuals of the population the are sorted. During the selection operation some of the individuals with highest score are chosen for reproduction process. During crossover operation, from the selected individuals some parts are exchanged in random position which results in producing a new set of chromosomes instead of old ones. In order to correct the stochastic errors which avoids a genetic drift by performing mutation operation to ensure the genetic assortment in population. Depending on small percentage of probability the position of few individuals is changed in a random manner.

B. Model of Intuitionistic Fuzzy Logicin Agriculture Drought classification

using real time datasets especially in this work climatic condition and agriculture dataset the variables involved are uncertain it means they are fuzzy in nature. The values of these variables are represented in linguistic terms instead of crisp values. While using fuzzy they denote the input variables by linguistic variables in terms of membership function alone but this is not sufficient due to the chance of existence of non-membership function. Such kind of special cases intuitionistic fuzzy is suitable to represent membership, non -membership and hesitation function during uncertain conditions.

Definition 1: Each variable of the dataset A is denoted as

$A = \{< x, \mu_A(x), \nu_A(x) > | x \in X\}$ (1)

Where$\mu_A(x)$ is a degree of membership, $\nu_A(x)$ is a degree of non-membership and their values of each element x varied between 0 to 1 [12].

. (i.e) $\mu(A)$& $\nu(A)$: $X\rightarrow[0,1]$;$0 \leq \mu_A(x) + \nu_A(x) \leq 1$ (2)

Definition 2: For each intuitionistic fuzzy index hesitation degree is denoted as

$\Pi_A(x) = 1 - \mu_A(x) - \nu_A(x)$,

(3)

for every $x \in X$, $0 \leq \pi_A(x) \leq 1$. Obviously, it expresses a lack of knowledge of whether $x\in A$ or not [13].

In this work to perform clustering on the agriculture drought dataset the values of variables are converted to intuitionistic fuzzy values and then subtractive clustering is done to group the instances with similar characteristics.

III. PROPOSED METHODLOGY

A. Chaos Genetic based intuitionistic Fuzzy Subtractive clustering

Internet of Things has a strong backbone of various enabling technologies like Wireless Sensor Networks, Cloud Computing, Big Data, Embedded Systems, Security Protocols and Architectures, Protocols enabling communication, web services, Internet and Search Engines. This proposed technique used Cloud Computing which is also known as on-demand computing, is a type of Internet based computing which provides shared processing resources and data to computers and other devices on demand.

The main objective of this proposed work is to manage heterogeneous information of agriculture data acquired from IoT based sensors. This work aims at prediction of agriculture drought in advance to avoid extreme crops stress and wilting. The collected dataset is preprocessed by applying data normalization using Z score technique. Which results in improving the quality of dataset.

After that to handle imprecise knowledge about agriculture dataset this work devised chaotic Genetic Algorithm integrated Intuitionist Fuzzy Subtractive Clustering. After grouping similar instances, it is fed in to feed forward neural network for prediction of agriculture drought for a specific season in advance.

The overall framework of this proposed methodology is shown in the figure

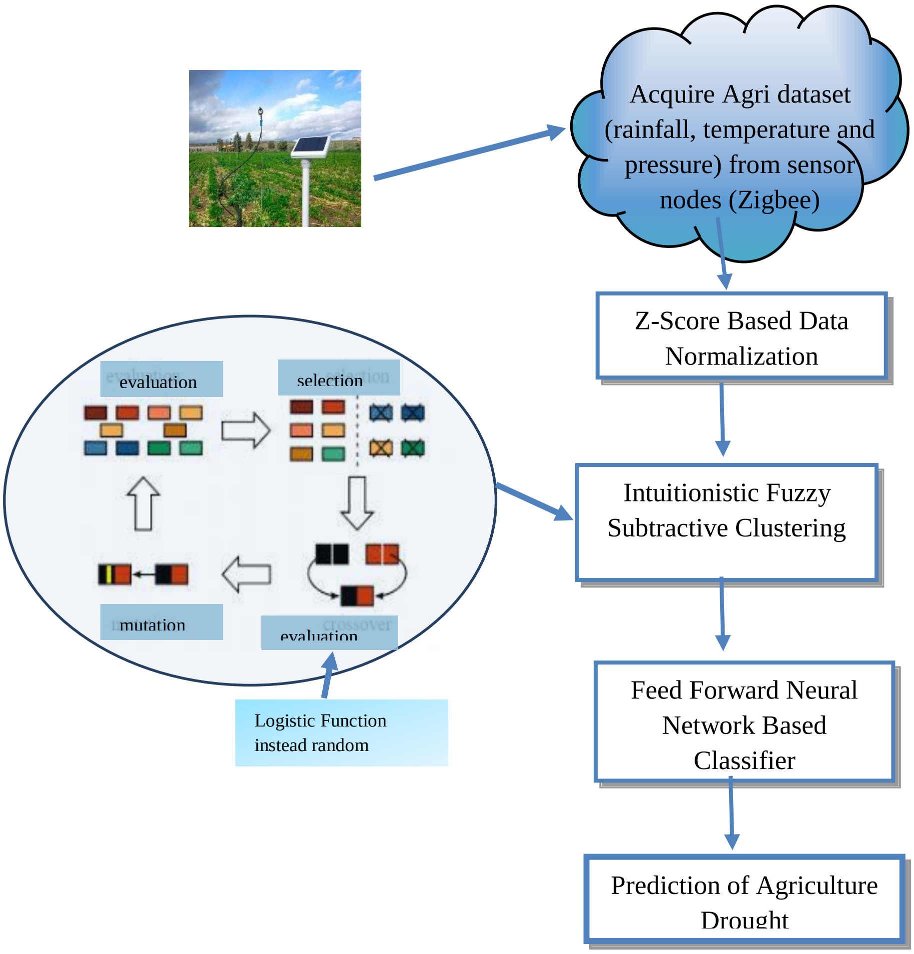


Figure 1: Framework of proposed IoT based Agriculture datasets using Genetic Algorithm integrated Intuitionistic Fuzzy Subtractive Clustering

B. Dataset Description

The dataset was collected from open govenment Data platform India webportal. This dataset consists of 8 different districts of all over India to predict the Presence of Drought by acquiring information of climatic condition like temperature, air pressure and rainfall along with their average values from the year 2001 to 2016.

The dataset consists of 1535 records of 8 different districts namely Amaravati, Nagpur, Pune Nashik, Aurangabad, Solapur, Yavatmal and Latur. The attributes involved in the process predicting possibility of drought in agriculture land are district, month, year, rainfall, average rainfall, temperature, average temperature, pressure and average pressure. The attribute values are in different datatypes like numerical or characters. To perform the prediction process the raw dataset has to be preprocessed which is done using data normalization.

C. Z-Score Data Normalization

Prior to classification of instances of agriculture dataset as presence or absence of drought the values of instances are transformed to fall under the range of 0 to 1 using Z-Score normalization. Z-score transforms data values in a linear manner by keep a mean of zero and standard deviation of 1. Thus, it transforms the data by converting the values to a common scale range. The formula is as follows:

$$\mathbf{Z = (x - \mu) / \sigma} \quad (4)$$

where x is the concern variables actual value, μ and σ are the mean and standard deviation of attribute values, respectively.

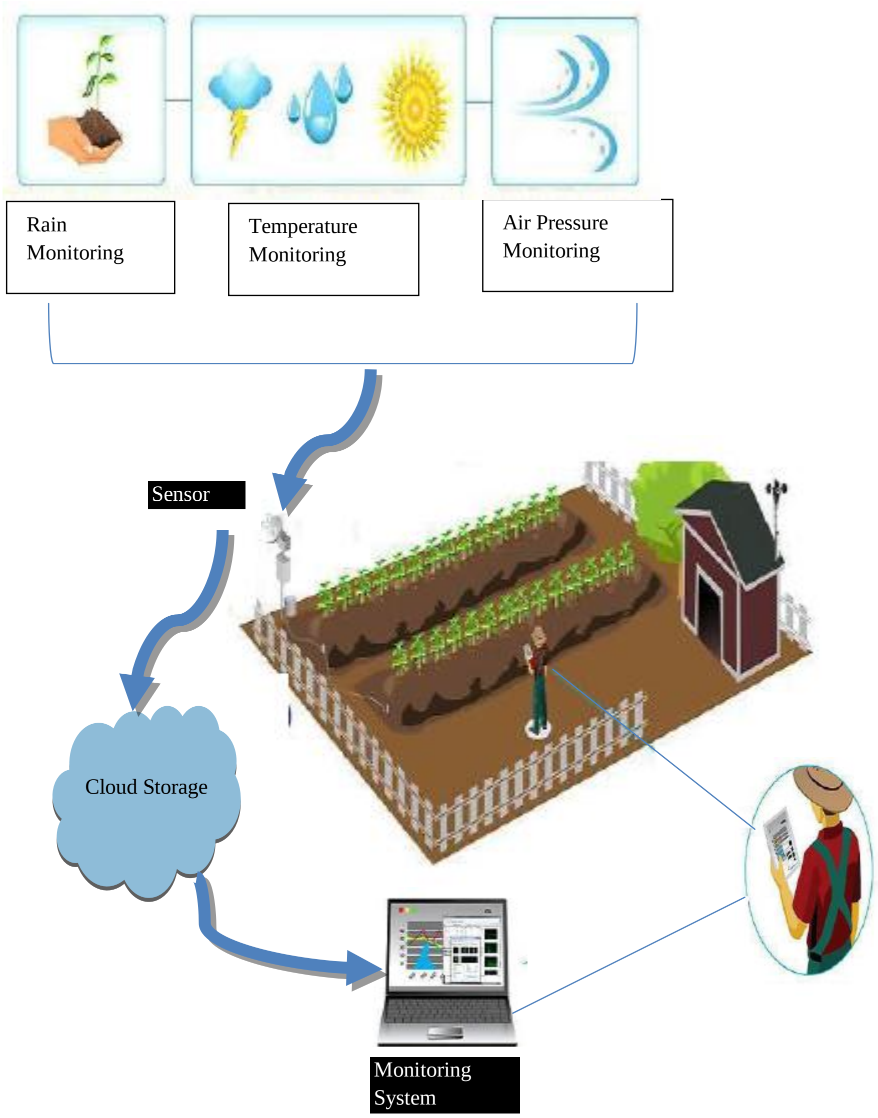


Figure 2 : Agriculture Drought Dataset Collection using IoT enabled Cloud Storage

D. Intuitionistic Fuzzy Subtractive Clustering (IFSC)

The Intuitionistic fuzzy subtractive clustering algorithm differs from other clustering algorithms. They are not interested in primary perceptive of number of clusters, therefore the algorithm works based on consideration of each data points as a cluster center.

IFSC algorithm allocates instances to each group by using membership, non-membership and hesitancy values [14]. Let X= ($x1$, $x2$, …$x_{M \times N}$) be an instance with N x M records to be partitioned into c clusters where xi signifies features or attributes of the instances. The IFSC clustering algorithm is an iterative utility and intended at reducing the inter cluster similarity and IFE. The objective function of IFSC clustering is well-defined as trails.

$$J = \sum_{i=1}^{C}\sum_{k=1}^{n} u_{ik}^{*m} d(x_k, v_i)^2 + \sum_{i=1}^{C} \pi_i^* e^{1-\pi_i^*} \quad \text{with } m = 2 \tag{5}$$

where c is the number of clusters, n is the number of data points, u^*_{ik} is the intuitionist fuzzy membership matrix, v_i is the cluster center; is $d(x_k, v_i)$ the distance measure between data points and cluster center; and is $\pi_i^* e^{1-\pi_i^*}$ the intuitionist fuzzy entropy.

$$u_{ik}^* = \frac{1}{\sum_{j=1}^{c}\left[{[d_{ik}^2]}/{[d_{jk}^2]}\right]^{1/m-1}} + \pi_{ik} \quad (6)$$

$$v_i^* = \frac{\sum_{k=1}^{n} u_{ik}^* x_{ik}}{\sum_{k=1}^{n} u_{ik}^*} \quad (7)$$

Normalized Euclidian distance measure is used to calculate thedistance between the data points (A) and cluster center (B) and defined as

$$d(A,B) = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(\mu_A(x_i) - \mu_B(x_i))^2 + (v_A(xi) - v_B(x_i))^2}$$

(8)

During implementation, matrix v^* is randomly initialized, and then u^* and v^* are updated through an iterative process using Equations for membership, non-membership and distance calculation.

Thus, the measure of density to each point is achieved and the potential is computed. when the data point's potential is the biggest one compared with the other potentials, first cluster center is declared. To find the next center, subtract a potential of other data from the potential of first cluster, if the difference is big, this means it is far from influence of center 1 and input value regarding with this potential is candidate to be next center.

E. Chaos Genetic Algorithm

The chaos system works on very sensitive systems and chaos theory is a portion of mathematics [11]. A very small change leads to make a system behave entirely different. The minute changes in beginning position of chaotic system results in a big difference after a while. The chaotic system is a non-linear which has few properties like regularity, randomness, sensitivity and ergodicity to initial situations.One of the main issues in standard genetic algorithm is its premature convergence, particularly when there are more local optima while resolving optimal problem [6]. In such case it is not possible for most of the operators to generate offspring to surpass their parents. Thus, in this work to optimize the performance of intuitionistic fuzzy subtractive clustering chaotic genetic algorithm is introduced to discover the optimal cluster centers during each iteration till all the instances of the agriculture dataset instances are grouped more precisely. The chaotic genetic algorithm overcomes the premature converge by the dynamic mapping performed by the chaotic property which adapts the logistic mapping in genetic operation especially in crossover process during offspring generation.

Instead of using randomness in genetic algorithm to perform crossover and mutation chaotic mapping is used. The initial generation of population is usually unevenly distributed and it is far away from the optimal solution. Hence its efficiency is very less and it need to perform a greater number of iterations to discover global optima. Henceforth, this work uses uniform distributed of the tent map to produce initial population and logistic map is used for cross over each time a random number is needed. It is shown clearly in the figure 3.

Logistic Function as a Genetic Operator

Logistic mapping is one of the most significant dynamic mapping behaviors of chaos. It defines noninvertible mapping whose value lie in the interval [0 1]. In this proposed work uniform crossover is used instead of randomness. In crossover while swapping the first and second parent each gene in the solution of the first offspring is generated by copying the relevant gene form the solution part of either first or second parent which is selected according to binary crossover mask. When the mask is 1 it copies the first parent gene, else if the mask is marked as o then the gene of second parent is copied. Bits on location of λ value are inferred from the first parent, mask bits are generated using modified mask belonging to first parent. The logistic function is defined as follows

$$Z_{n+1} = \lambda Z_n (1 - Z_n) \quad (9)$$

This function takes the value of Zn whose value varies between 0 and 1, and changes into a new value Z_{n+1}. The new value of Z is then used into the formula and so on. Such kind of processing is known as iterative process. The parameter λ holds a constant value between 0 and 4. It is kept constant during the iteration process. The value of λ discovers the behavior of the variable Z such as convergent, periodic or chaotic. If the value of λ is smaller than 3 then it led to convergent, if its value between 3 to 3.56 then the behavior of Z is periodic else if the value of λ increases, then four, eight, sixteen etc. values of z variable alternate. The solutions of equation(9) for λ between 3.56 and 4 become fully chaotic: neither convergent nor periodic, but variablewith no distinct pattern.

In crossover operation the mask is updated by the logistic function using the λ value stored both in chromosome and mask itself as input. The value of x_z is got by interpreting mask bits as real values whose value ranges from 0 to 1. New mask value will be x_{z+1} like the same bit interpretation of equation (9). This altered crossover operation results in self-directed genetic search space of solution using theory of chaos.

Algorithm: Optimizing Intuitionist fuzzy subtractive clustering using chaos genetic algorithm
Procedure

1. According to the specific system, the number of data instances, the radius of neighborhood and the error should be given.
2. Compute the density of every data point, and the highest density of the point is chosen as x_{c1}
3. According to equation (10) the density of all data points is updated. The data point x_{c2}which corresponding to the larger density value is chosen as the second cluster center. The selection is carried out iteratively, until the stopping criteria achieved. The results of the clustering are clustering number and cluster centers, all of which are adaptive formulated according to the effect of the cluster centers in each dimension.

$$Dn_i = Dn_i - Dn_{c1} \sum_{j-1}^{N} exp\left(-\frac{\|x_i - x_{c1}\|^2}{\left({}^{r_b}/_2\right)^2}\right) (10)$$

4. The results of aforementioned including the clustering number and cluster centers are chosen as the FCM initial values. The initial Intuitionistic fuzzy partition matrix $u_{ik}^*(0)$ is also set contemporaneously as follows

$$u_{ik}^*(0) = \frac{1}{\sum_{j=1}^{c}\left[{}^{[d_{ik}^2}/_{[d_{jk}^2}\right]^{1/m-1}} \quad (11)$$

where*D jk*, which is calculated firstly, signifies the distances between *k* th data point and *j*thinitialcluster center

5. Calculate the center values according to equation (7)
6. Update the Intuitionist fuzzy partition matrix u_{ik}^* according to Eq.(6)
7. GA based refinement

a. Construct the initial population (p1)
b. Calculate the global minimum (Gmin)
c. For i = 1 to N do

- Perform reproduction
- Apply the crossover operator between each parent using chaotic logistic mapping according to the equation (9).
- Perform mutation and get the new population. (p2)
- Calculate the local minimum (Lmin).
- If Gmin<Lmin then
- Gmin = Lmin;
- p1 = p2;

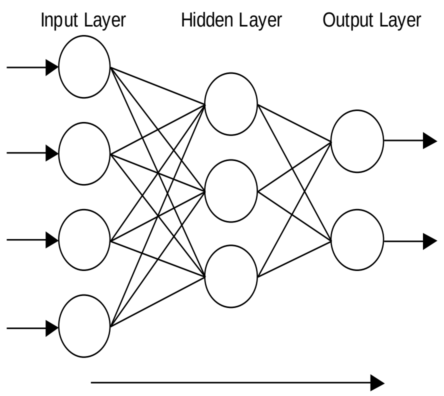
d. Repeat

8. Terminate the process if the condition $\|u_{ik}^{*} - u_{ik-1}^{*}\| < \varepsilon$, else k – k+1 go to step (5)

Output :Optimal clustering of agriculture drought dataset

Artificial Neural Networks to validate the process of Intuitionistic Fuzzy Subtractive Clustering

A computational mechanism which has the ability to collect, represent and compute the given dataset to a useful knowledge of information is done using artificial neural network which maps the given dataset to the different representation [15]. In general ANN is trained using the set of known inputs and outputs. The main objective to design ann is to predict the outcomes from the given input which was not known previously. The most common learning algorithm is back propagation which uses multi-layered network consists of input, hidden and output layer as shown in figure 1. The neurons in hidden and output layers compute their input by multiplying each of their inputs by their corresponding assigned weights and summing the products and transforming them using non-linear transfer function to produce the output. The sigmoid function used in this approach is S-Shaped which is commonly adapted in this method as shown in figure 2. ANN learns the pattern by adjusting the weights between the neurons based on the occurrence of error between the expected output and observed output values. Finally in this training phase, the artificial neural network denotes a model, which would be able to forecast a target value given an input value



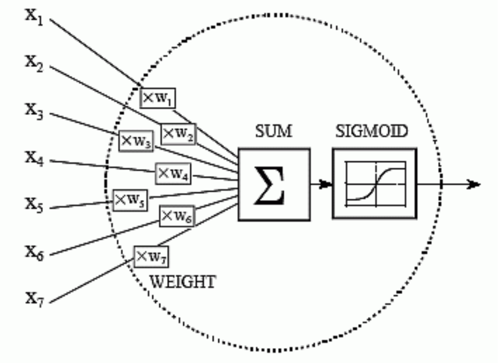


Figure: Model of ANN with inputs, weights, summing function and sigmoid transfer function as activation function

As shown in the figure the hidden node which receives the input value sums the weighted values from all the receiving nodes which it is connected in the previous layer. Legally, the input that a solitary node obtains is weighted agreeing to Eq. (12).

$$net_j = \sum_i wt_{ij} \cdot Out_i \quad (12)$$

wherewt$_{ij}$ denotes the weights amid node i and node j, and out$_i$ is the output from node j such as Eq. (2).

$$Out_j = fsf(net_j) \quad (13)$$

The function fsf is typically a non-linear sigmoid function that is functional to the biased summation of inputs beforehand the signal processes to the subsequent layer. Benefit of the sigmoid purpose is that its derived can be stated in relations of the task itself such as Eq. (14).

$$fsf'(net_j) = fsf(net_j)\,(1 - fsf(net_j)) \quad (14)$$

The Multi-layer Perceptron (MLP) can distinct data that are non-linear since it is 'multi-layer', and it usually comprises of three kinds of layers. The input layer is the first layer, where the nodes are the basics of a feature vector. The hidden layer is the inner layer which is ranked as second type of layer because it does not hold output unit. The output layer is the third type which delivers the output of the model. Each node involved in this network is interconnected to the nodes both in the previous and the proceeding layers by the link termed as connection. Each connection is associated with a specific weight values.

The error Err, for one input training pattern tp, is a function of the desired output vector dout, and the actual output vector, aout, given by Eq. (15).

$$Err = \frac{1}{2}\sum_k (dout_k - aOut_k) \quad (15)$$

The error back propagated through neural network and the error is minimized by changing the weight between layer. So, the weight can be expressed in Eq. (16).

$$wt_{ij}(n+1) = \eta\ (\delta_j.aOut_i) + \alpha\ \Delta wt_{ij} (16)$$

Where the learning rate parameter, j is η, δ an index of the rate of variation of the error, and α is the energy parameter. This procedure of feeding forward signals and back propagating the error is recurrent iteratively till the fault of the network as a complete is lessened or touches an satisfactory amount. Consuming the back propagation, the weight of the each influence can be acknowledged and the weight can be used for classification. This uses technique for resolving the weight using back propagation.

Algorithm: Procedure for IoT enabled Agriculture Drought prediction using Chaotic Genetic Algorithm integrated Intuitionist Fuzzy Subtractive Clustering

Input: Collect input dataset from open government Data platform India web portal

1. Perform Z-Score normalization on agriculture dataset to transform the values fall under same range of values
2. Cluster the instances of dataset using Intuitionist fuzzy Subtractive clustering
    a. Define membership, non-membership and hesitation value of each instances depending on the cluster belongingness.
    b. Applying Intuitionist Fuzzy Subtractive Clustering for determining the similar pattern of instances to discover whether the instance results in drought or not.
    c. During each iteration of re-computation of clusters, the centroid is selected using chaotic genetic algorithm which handles uncertainty by well defining the instances which are outliers, instances which present in borders of two clusters to overcome vagueness in prediction of drought possibility.
3. After completion of clustering the dataset the instances of similar clusters are given as input to the feedforward neural network to validate the performance of clustering done by Chaotic genetic with IFSC.

Output: Prediction of agriculture drought in each district of the selected dataset.

V. SIMULATION RESULT

The proposed technique Chaos Genetic based intuitionist Fuzzy Subtractive clustering (CG-IFSC) was simulated using Matlab software. The dataset was collected from open government Data platform India webportal. This dataset consist of 8 different districts of all over India to predict the Presence of Drought by acquiring information of climatic condition like temperature, air pressure and rainfall along with their average values from the year 2001 to 2016. The collected dataset used for predicting the occurrence of agriculture drought in future on the corresponding districts to provide necessary information about drought condition to farmers and plan accordingly.

The performance of CG-IFSC is compared with three different existing approaches namely Fuzzy C-Means (FCM), Fuzzy Subtractive Clustering (FSC) and Intuitionist Fuzzy C-Means Clustering (IFCM). The evaluation metrics used in this work are precision, recall, f-measure, Root Mean Square Error and prediction Accuracy.

Evaluation metrics

- True Positives (TP) - These are the correctly predicted positive values which means that the value of actual class of drought is yes and the value of predicted class of drought is also yes
- True Negatives (TN) - These are the correctly predicted negative values which means that the value of actual class of drought is no and value of predicted class of drought is also no.
- False positives and false negatives, these values occur when your actual class contradicts with the predicted class.
- False Positives (FP) – When actual class of drought is no and predicted class of drought is yes.
- False Negatives (FN) – When actual class of drought is yes but predicted class of drought in no.

Precision - Precision is the ratio of correctly predicted positive observations to the total predicted positive observations.

Precision = TP/TP+FP

Recall - Recall is the ratio of correctly predicted positive observations to the all observations in actual class - yes.

Recall = TP/TP+FN

F-Measure - It is the weighted average of Precision and Recall. Therefore, this score takes both false positives and false negatives into account

F-measure = 2*(Recall * Precision) / (Recall + Precision)

Accuracy -Accuracy is the most intuitive performance measure and it is simply a ratio of correctly predicted observation to the total observations.

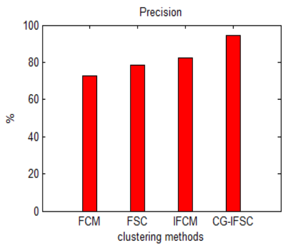
Accuracy = (TP+TN)/(TP+FP+FN+TN)

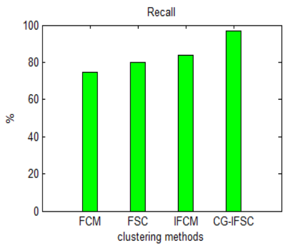
Table I: Performance Comparison based on Precision Recall and F-measure

	Precision	Recall	F-measure
Fuzzy C-means	72.5	74.82	78.21
Fuzzy Subtractive Clustering	78.6	80.03	81.72
Intuitionistic Fuzzy C-means	82.5	83.91	84.39
CG-IFSC	94.62	96.84	97.42

The Table I and the figures shows the performance comparison of four different clustering techniques namely Fuzzy C-Means (FCM), Fuzzy Subtractive Clustering (FSC) and Intuitionist Fuzzy C-Means Clustering (IFCM) and Chaos Genetic based intuitionist Fuzzy Subtractive clustering (CG-IFSC).

The result reveals the performance of the proposed CG-IFSC produces more promising results compare to the existing methods because the intelligence of chaotic genetic algorithm in selection of cluster centroid which influence the radius of the cluster is optimally performed by overwhelming the early convergence and avoids local optimization to produce better results even in case of uncertainty and vagueness in handling Iot based agriculture drought forecasting.





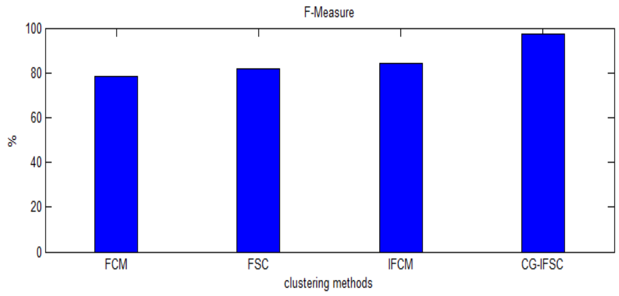


Table II Performance Measure based on Prediction Accuracy and Root mean Square

	RMSE	Prediction Accuracy
Fuzzy C-means	0.086	0.75
Fuzzy Subtractive Clustering	0.075	0.82
Intuitionistic Fuzzy C-means	0.063	0.86
CG-IFSC	0.012	0. 94

The above table shows the prediction accuracy and the RMSE of the feed forward neural network when the

clustered input of four different clustering methods are used. The result shows that the performance of the proposed **CG-IFSC**produced highest prediction accuracy with lowest error rate due to its capability of handling uncertainty in prediction of drought in agriculture land. The chaotic genetic algorithm greatly influenced the process of intuitionistic fuzzy subtractive clustering to determine the optimal centroids to frame significant cluster formation of similar instances. While other existing techniques failed to handle such vagueness prevail in the prediction of agriculture drought forecasting.

VI. CONCLUSION

The agriculture is considered as the backbone of Indian economy. The increasing population and pollution causes agriculture drought which refers to circumstances when soil moisture is insufficient and results in the lack of crop growth and production. The invention of agriculture IoT produces positive impact in forecasting agriculture drought. But still there is a problem in efficient usage of such collected information of agriculture dataset due to the presence of vagueness and uncertainty. Thus this work overwhelms these issues by modeling chaotic genetic algorithm based intuitionist fuzzy subtractive clustering for drought forecasting in cloud storage based IoT agriculture. By introducing degree of hesitation in intuitionistic fuzzy and extended search space of clustering similar instance of agriculture dataset produces significant accuracy in agriculture drought forecasting. From the proof of simulation result it is revealed that the proposed CG-IFSC produces best results even in presence of uncertainty on IoT based agriculture drought forecasting.

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