ESTIMATION OF PRECIPITATION DURING THE PERIOD OF SOUTH WEST MONSOON USING NUMERICAL METHODS UNDER C-PROGRAMMING

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ABSTRACT

This paper briefly focuses on the literature review of an unsupervised machine learning competitive topology preserving Self organizing maps through Ho-Kashyap rule which is the best approach in precipitation prediction to solve the data reduction with fine resolution of atmospheric models through the extensive classifying nature of the proposed model. The Model of precipitation prediction via neural networks explains that self organizing maps along with Ho-Kashyap Rule of pattern results in carrying forward the weather forecasting phenomenon at input level. The classifier provides space to separate the non linear regression pattern resulted in defining a decision pattern, reveals the precipitation prediction of low time and less number of hidden layers. Every predicate model takes input data, Processes with specified levels to variable level and counter with a variable set reduction to reach the decision of prediction in a more confirm levels. To provide a critical modeling design using non liner regression namely a support vector machine which is very non interpretable neural network designed as a two stage activity in prediction with more than three kernel functions for improving the performance of the SVMs experts in predicting the future weather happenings through its classifier. Recording the input data set parameters of weather compared with a MLP (multilayer preceptron), SVM has more esteemed performance in forecasting the parameter with respect to others in a two stage procedure
initially with self organizing maps and with best practice of more kernel functions investigation in weather forecasting. The prediction of precipitation using above methods resulted in predicting a qualitative estimate of the precipitation like mild to very mild, heavy to very heavy etc. To address the above issue we made an attempt in this paper to quantitatively predict the precipitation over a given period of time using numerical methods under C programming. The major contribution of the present work is to forecast the weather using numerical methods to quantitatively estimate the precipitation over a given period of time.

**Keywords:** SVM, Kernal function, neural networks, Precipitation, critical modeling design, non linear regression.

### 1.0 INTRODUCTION

Weather prediction is a complex process, which completely depends upon the atmospheric conditions. High speed computers, wired and wireless sensors, meteorological satellites and weather radars are the tools used to collect the weather data for weather forecasting. Unseasonal change in climate results in increase in precipitation levels leads to unexpected flood which makes the farmers lose their crop [1]. This paper mainly deals with the occurrence of rainfall that will definitely provide knowledge to the farmers, what to sow and when to sow seeds in order to reap crop. This paper tells about future prediction of precipitation through the machine learning self organizing map [2] as advanced statistical development of rare event classifier. Early prediction-based alert broadcasting may help in operating the existing flood control systems with maximum efficiency, which minimizes losses, such as evacuation, flow diversion, alerting the population, preparedness of the disaster mitigated team, etc. to provide a system alert messaging and make sure of reliability in report given as not a simple statement of “could happen” but its so deterministic message of “certainly weather happens”. However, all facts described above have proved of immense use to the users, still the inter dependence of one or other parameters on the rainfall is not touched upon in detail. For example the average temperature over a period of say one month and the average rainfall over the same month observed over a period of one or two years may reveal a definite correlation between the temperature and rainfall. Similarly the humidity and wind velocities etc may also have a conclusive correlation between the above parameters and rainfall [6].

### 2.0 LITERATURE REVIEW

Literature review brings the detailed statement of SVM (Support Vector Machine), MLP of Artificial Neural Network and its usage. Support Vector Machine algorithm relies on statistical learning theory. The principle of Support Vector Machines is to map the original data X into a feature space F with high dimension via non linear mapping function and builds an optimal hyper plane in new space [3]. SVM techniques can be applied to both classification and regression. In classification, an optimal hyper plane separates the data into two classes, whereas for regression a hyper plane is to be constructed that lies close to as many points as possible [5], \( G = \{(x_t, d_t)\}N^2 \). Support Vector Regression (SVR) predicts the maximum temperature at a location. Regression is the problem of estimating a function based on a given data set. [4] Consider a data set where \( x_i \) is the input vector, \( d_i \) is the desired result
and \( N \) corresponds to the size of the data set. The general form of Support Vector Regression estimating function is 
\[
    f(x) = \langle w, \phi(x) \rangle + b
\]
where \( w \) and \( b \) are the co-efficient that have to be estimated from data. \( F(x) \) is the non linear function in feature space.

Recently, Automatic indexing and retrieval based on image content has become more desirable for building large volume image retrieval applications. “A Weather Forecasting System using concept of Soft Computing: A new approach” is a design which has an image, with actual data. They relate the data of forthcoming weather events with previous records and history.

The trained MLP of Artificial Neural Network is used for the prediction and classification of thunderstorm with appreciable level of accuracy. Its work reports the Artificial Neural Network design with minimum input parameter, however increase in input parameter will effectively increase the prediction accuracy.

Two models of rainfall prediction:

a) Artificial Neural Network ANN model
b) Multi Regression MLR model.

Another model called a Feed Forward Neural Network FFNN was developed and implemented to predict the rainfall on yearly and monthly basis.

Recent papers on above topics are reported in the literature review.

### 3.0 METHODOLOGY OF PRESENT WORK

A detailed analysis of Step-wise contribution of non interpretable data is collected from the literature and the values are tabulated in table 1. It may be noted that the words rain, rainfall and precipitation are used interchangeably for incorporating the agent based decision system.

1. The dataset with respective parameters were framed (Average temperature [t] Vs Average Rainfall [r] over a period of time).
2. 12 sets of temperature Vs rainfall are noted down.

An empirical equation of the form 
\[
    R = c_0 + c_1 t + c_2 t^2 + \ldots + c_n t^n
\]
, based on numerical methods is written.

3. Where \( R \) = Computed rain; \( C_0, C_1 \ldots C_n \) are constants arrived at using C programming based on Numerical methods and \( t \) is the temperature for an average rainfall [r].
4. The above set of 12 values when fed in to a C program (Program shown elsewhere in the paper under numerical methods will give the constants \( C_0, C_1 \ldots C_n \)).
5. Equations upto 5th order were tried and it is observed that the variation between \( R \) and \( R \) is marginal beyond second order equation. Hence, second order equations are used throughout the investigations in this paper.
6. The ratio (\( p \)) namely 
\[
    p = \left( \frac{R-r}{r} \right) 100
\]
    is computed for each value of \( t \) and \( r \).
7. The values of \( t, r, C_0, C_1, C_2, R \) and the above ratio are entered in table 1 to 5.
8. As \( p \) tends to zero the computed rainfall equals the actual rainfall. Hence the smaller the value of \( p \) the more effective the equation used for computing \( R \).
9. It has been established that an excellent correlation exists between the computed rainfall (\( R \)) and the actual rainfall (\( r \)) for a given temperature (\( t \)), in region segmentation method.
10. The value of ‘R’ computed over the entire region of June to September appears to give a poor correlation with ‘r’. Hence the entire region is segmented into four namely June, July, August and September. For each of these region segments, individual $C_0, C_1, C_2,$ are obtained and equations for ‘R’ and ‘p’ are written.

11. It is observed that the region segmentation method offers excellent correlation between ‘R’ and ‘r’ for each region.

12. Hence, the equation developed for ‘R’ can be effectively used for computation of unknown precipitation/rain, once the average temperature is known.

4.0 PRESENT WORK

Literature revealed a few methods of Predicting/forecasting precipitation using neural networks, genetic algorithms etc. These methods involve extensive application of softwares, programmes and call for human judgements in interpreting the results for forecasting purposes.

We have developed, in this paper, a numerical method using turbo C++ for developing nth order equations for computing the precipitation using a vast data base of precipitation Vs temp over given past few years. For our analysis we have chosen south/west monsoon period (June to September) at Vijayawada town, AP, S. India over the years 2000 to 2010.

The average temperatures and precipitation during above period for each 10 days starting from June to September from 2001-2010 are noted down. Hence we have in each month 3 sets of readings and a total of 12 sets of readings namely average temperature for 10 days (t) in °C, and average rainfall (r) in mm of Hg. An attempt is made to investigate, whether a correlation exist between temp (t) and rainfall (r), if so what will be the nature of equations governing the correlation. To achieve this, a numerical methods approach is adopted using turbo C- Programme [6]. The percent deviation of (R) from (r) namely (p) is computed. As p $\rightarrow 0$, R approaches r or in other words, the computed temp is equal to the actual rain. For the 12 sets of readings the values of $C_0, C_1, \ldots, C_n$ are noted down and the values of R and p are computed and noted down. The smaller the value of (p) the closer the computed values to the actual values of (r). Equation upto 5th order (n=5) were tried. However beyond 2nd order, the effect is very marginal and hence 2nd order equations are finalized for the present investigation.

\[ R = c_0 + c_1 t + c_2 t^2 + \ldots + c_n t^n \]

Is arrived at,

Where R is the computed rain for a given average temp (t) °C, for which the corresponding average rain is (r) mm of Hg and $C_0, C_1, \ldots, C_n$ are constants, arrived at using turbo C- Programme [6]. The percent deviation of (R) from (r) namely (p) is computed. As p $\rightarrow 0$, R approaches r or in other words, the computed temp is equal to the actual rain. For the 12 sets of readings the values of $C_0, C_1, \ldots, C_n$ are noted down and the values of R and p are computed and noted down. The smaller the value of (p) the closer the computed values to the actual values of (r). Equation upto 5th order (n=5) were tried. However beyond 2nd order, the effect is very marginal and hence 2nd order equations are finalized for the present investigation.

\[ R = C_0 + C_1 \times t + C_2 \times t^2 \quad \ldots (1) \]

\[ p = \frac{(R-r)}{r} \times 100 \quad \ldots (2) \]

Hence the values of t,r , $C_0, C_1, C_2$, R and p for the 12 sets of t and r are entered in table 1. It is seen from table 1, that p varies from -27 to +13, which is not a promising correlation. Hence a region segmentation method is tried.
C- PROGRAM FOR Calculating CONSTANTS C0, C1, C2

Turbo C++ is installed and the below c – program is executed. We will be asked to specify the number of given sets (n) and the order of the equation. In the present investigation n= 12 and order = 2.

C- Program
#include <conio.h>
#include <math.h>

void main()
{

int i,j,k,n,m;
float x[50],y[50],a[50][50],s[50],c[50];
clrscr();
printf("Enter the value of n:\n\n");
scanf("%d",&n);
printf("enter the degree of teh reqd. equ. : \n");
scanf("%d",&m);
printf("Enter the value for x and y \n");
for(i=0;i<n;i++)
{
scanf("%f%f",&x[i],&y[i]);
}
s[0]=n;
for(i=1;i<(2*m+1);i++)
{
s[i]=0;
for(j=0;j<n;j++)
{
    s[i]=s[i]+pow(x[j],i);
}
}
for(i=0;i<(m+1);i++)
{
    for(j=0;j<(m+1);j++)
    {
        a[i][j]=s[i+j];
    }
}
for(i=0;i<n+1;i++)
{
    a[i][m+1]=0;
    for(j=0;j<n;j++)
    {
        if(i==0)
            a[i][m+1]=a[i][m+1]+y[j];
        else
            a[i][m+1]=a[i][m+1]+pow(x[j],i)*y[j];
    }
}
for (k=0;k<m+1;k++)
{
    for (i=0;i<m+1;i++)
    {
        

}
{ if(i!=k)
  for (j=k+1;j<m+2;j++)
  { a[i][j]=a[i][j]-(a[i][k]*a[k][j])/a[k][k];
  }
}

for(i=0;i<m+1;i++)
{ c[i]=(a[i][m+1]/a[i][i]);
  printf("the value of c[%d] is :%f\n",i,c[i]);
}
getch();

4.1 Region Segmentation Method

We segmented the entire south west monsoon period into 4 (month wise) regions and for each region \( C_0, C_1 \) and \( C_2 \) are obtained using the above C- Programme (3 sets of readings with \( n \) equal to 2 and 2\textsuperscript{nd} order equation) separately. The corresponding equations are as given,

\[
R = C_0 + C_1 t + C_2 t^2 \quad \ldots (3)
\]

\[
p = \left[ \frac{R-r}{r} \right] 100 \quad \ldots (4)
\]

The values of \( t, r, C_0, C_1, C_2, R \) and \( p \) are entered in table 2.

Similarly, equations are developed for the month of july by computing \( C_0, C_1 \) and \( C_2 \) separately.

The equations are given below,

\[
R = C_0 + C_1 t + C_2 t^2 \quad \ldots (5)
\]

\[
p = \left[ \frac{R-r}{r} \right] 100 \quad \ldots (6)
\]

The values of \( t, r, C_0, C_1, C_2, R \) and \( p \) are entered in table 3.

Similar procedure is followed for August and September and the values are entered in tables 4 and 5 respectively.

The corresponding equations are,

For August, 
\[
R = C_0 + C_1 t + C_2 t^2 \quad \ldots (7)
\]

\[
p = \left[ \frac{R-r}{r} \right] 100 \quad \ldots (8)
\]
For September,

\[ R = C_0 + C_1t + C_2t^2 \quad \ldots (9) \]

\[ p = \left( \frac{R-r}{r} \right) \times 100 \quad \ldots (10) \]

It is seen from tables 2, 3, 4 and 5 that an excellent agreement exists between the temperature (t) and precipitation (r) throughout the south west monsoon period from June to September under segmented method. The value of p varies from -0.01 to 0. Hence the above equations (region wise) can be effectively used for predicting the unknown precipitation (R) once the average temperature (t) is known.

**Table 1: (Unsegmented Method)**

This table contains the Average temperature Vs rainfall for each ten days starting from June to September during the south west monsoon period. In this table ‘t’ refers to avg. temp in °C, ‘r’ refers to avg. precipitation in mm of Hg, \( C_0, C_1 \) and \( C_2 \) (constants arrived at using numerical methods under C-Programming), ‘R’ refers to the computed precipitation in mm of Hg for an avg. temperature ‘t’ for which the avg. rainfall is ‘r’. ‘p’ is the percent variation of ‘R’ from ‘r’.

Where,

\[ R = C_0 + C_1 \times t + C_2 \times t^2 \quad \ldots (1) \]

\[ p = \frac{(R-r)}{r} \times 100 \quad \ldots (2) \]

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Avg.Temp(t)</th>
<th>Avg Precipitation (r)</th>
<th>C0</th>
<th>C1</th>
<th>C2</th>
<th>R</th>
<th>p</th>
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</thead>
<tbody>
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<td>2.993061</td>
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</tr>
</tbody>
</table>
Table 2: Segmented method, for the segment (June)

This table contains the Average temperature Vs rainfall for each ten days for the month of June during the south west monsoon period. In this table ‘t’ refers to avg. temp in °C, ‘r’ refers to avg. precipitation in mm oh Hg, \( C_0, C_1 \text{ and } C_2 \) (constants arrived at using numerical methods under C-Programming), ‘R’ refers to the computed precipitation in mm of Hg for an avg. temperature ‘t’ for which the avg. rainfall is ‘r’. ‘p’ is the percent variation of ‘R’ from ‘r’.

Where,

\[
R = C_0 + C_1 \times t + C_2 \times t^2 \quad \ldots (3)
\]

\[
p = \frac{(R-r)}{r} \times 100 \quad \ldots (4)
\]

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Avg.Temp(t)</th>
<th>Avg Precipitation (r)</th>
<th>C0</th>
<th>C1</th>
<th>C2</th>
<th>R</th>
<th>p</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

Table 3: Segmented method for the segment (July)

This table contains the Average temperature Vs rainfall for each ten days for the month of July during the south west monsoon period. In this table ‘t’ refers to avg. temp in °C, ‘r’ refers to avg. precipitation in mm oh Hg, \( C_0, C_1 \text{ and } C_2 \) (constants arrived at using numerical methods under C-Programming), ‘R’ refers to the computed precipitation in mm of Hg for an avg. temperature ‘t’ for which the avg. rainfall is ‘r’. ‘p’ is the percent variation of ‘R’ from ‘r’.

Where,

\[
R = C_0 + C_1 \times t + C_2 \times t^2 \quad \ldots (5)
\]

\[
p = \frac{(R-r)}{r} \times 100 \quad \ldots (6)
\]

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Avg.Temp(t)</th>
<th>Avg Precipitation (r)</th>
<th>C0</th>
<th>C1</th>
<th>C2</th>
<th>R</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
### Table 4: Segmented method for the segment (August)

This table contains the Average temperature Vs rainfall for each ten days for the month of August during the south west monsoon period. In this table ‘t’ refers to avg. temp in °C, ‘r’ refers to avg. precipitation in mm oh Hg, \( C_0, C_1, \text{and } C_2 \) (constants arrived at using numerical methods under C-Programming), ‘R’ refers to the computed precipitation in mm of Hg for an avg. temperature ‘t’ for which the avg. rainfall is ‘r’. ‘p’ is the percent variation of ‘R’ from ‘r’.

Where,

\[
R = C_0 + C_1 \times t + C_2 \times t^2 \quad \ldots (7)
\]

\[
p = \frac{(R-r)}{r} \times 100 \quad \ldots (8)
\]

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Avg.Temp(t)</th>
<th>Avg Precipitation (r )</th>
<th>C0</th>
<th>C1</th>
<th>C2</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>0</td>
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</table>

### Table 5: Segmented method for the segment (September)

This table contains the Average temperature Vs rainfall for each ten days for the month of September during the south west monsoon period. In this table ‘t’ refers to avg. temp in °C, ‘r’ refers to avg. precipitation in mm oh Hg, \( C_0, C_1, \text{and } C_2 \) (constants arrived at using numerical methods under C-Programming), ‘R’ refers to the computed precipitation in mm of Hg for an avg. temperature ‘t’ for which the avg. rainfall is ‘r’. ‘p’ is the percent variation of ‘R’ from ‘r’.

Where,

\[
R = C_0 + C_1 \times t + C_2 \times t^2 \quad \ldots (9)
\]

\[
p = \frac{(R-r)}{r} \times 100 \quad \ldots (10)
\]

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Avg.Temp(t)</th>
<th>Avg Precipitation (r )</th>
<th>C0</th>
<th>C1</th>
<th>C2</th>
<th>R</th>
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</tr>
</tbody>
</table>
The consolidated values for the segmented method for the months of June, July, August and September are shown in table 6:

Table 6: Consolidated values for June to September under Segmented method

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Avg. Temp (°C)</th>
<th>Avg Precipitation ( cm)</th>
<th>C0</th>
<th>C1</th>
<th>C2</th>
<th>R</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>42</td>
<td>3</td>
<td>38.36042</td>
<td>-1.55991</td>
<td>0.017095</td>
<td>2.999696</td>
<td>-0.01013</td>
</tr>
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<td>33</td>
<td>5.5</td>
<td>38.36042</td>
<td>-1.55991</td>
<td>0.017095</td>
<td>5.499779</td>
<td>-0.00402</td>
</tr>
<tr>
<td>3</td>
<td>29</td>
<td>7.5</td>
<td>38.36042</td>
<td>-1.55991</td>
<td>0.017095</td>
<td>7.499867</td>
<td>-0.00177</td>
</tr>
<tr>
<td>4</td>
<td>25</td>
<td>9</td>
<td>-45.9998</td>
<td>4.699982</td>
<td>-0.1</td>
<td>8.999794</td>
<td>-0.00229</td>
</tr>
<tr>
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<td>27</td>
<td>8</td>
<td>-45.9998</td>
<td>4.699982</td>
<td>-0.1</td>
<td>7.999758</td>
<td>-0.00302</td>
</tr>
<tr>
<td>6</td>
<td>30</td>
<td>5</td>
<td>-45.9998</td>
<td>4.699982</td>
<td>-0.1</td>
<td>4.999704</td>
<td>-0.00592</td>
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<tr>
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<td>4.5</td>
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<td>0</td>
<td>4.5</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>32</td>
<td>4</td>
<td>20</td>
<td>-0.5</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>33</td>
<td>3.5</td>
<td>20</td>
<td>-0.5</td>
<td>0</td>
<td>3.5</td>
<td>0</td>
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<td>10.04872</td>
<td>-0.14998</td>
<td>3.399655</td>
<td>-0.01015</td>
</tr>
<tr>
<td>11</td>
<td>35</td>
<td>3.1</td>
<td>-164.878</td>
<td>10.04872</td>
<td>-0.14998</td>
<td>3.099619</td>
<td>-0.01229</td>
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<tr>
<td>12</td>
<td>36</td>
<td>2.5</td>
<td>-164.878</td>
<td>10.04872</td>
<td>-0.14998</td>
<td>2.499619</td>
<td>-0.01524</td>
</tr>
</tbody>
</table>

5.0 RESULTS AND DISCUSSIONS

1) Table 1 corresponds to unsegmented method where in the constants $C_0, C_1$ and $C_2$ are obtained as one lot for the entire south west monsoon period. (June to September).

2) It is seen from table 1 that $p$ varies from -27 to 13, and hence the correlation between $R$ and $r$ is not very promising.

3) Hence the entire region is segmented into 4 regions (month wise).

4) From tables 2, 3, 4 and 5 it is seen that an excellent agreement exists between $R$ and $r$ over the entire period under the segmented method. The value of $p$ varies from -0.01 to 0. This is reflected in table 6, where in the consolidated values are presented under one roof.

6.0 CONCLUSION

1) It has been concluded that the segmented method of forecasting of precipitation offers excellent correlation with in an accuracy of -0.01 % to 0 %.

2) The major contribution of the present work is that, the developed equations 3, 5, 7 and 9 can be effectively used for forecasting unknown average precipitation during the entire period of south west monsoon. (June to September) once the corresponding average temperature is known.
7.0 REFERENCES


