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# Analysis of Interpolation Methods for Temperature Records in Aurangabad District of Maharashtra

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***Abstract:*** ***In this research work, missing value analysis and interpolation strategies utilized on temperature records in Aurangabad district. The year wise maximum temperature and minimum temperature data of Aurangabad district for the duration 1901–2002 had been considered. For each data set, three months i.e. January, May, and August month used to be analyzed one after the other and the data sets with 5 missing values have been eliminated. The missing values of the temperature data sets have been interpolated by using the four interpolation strategies i.e. cubic, Spline, linear and nearest interpolation methods. The interpolating curves, evaluation of missing values and relative percentage error are then being compared.***
***Keywords: Missing values, Cubic Interpolation, Spline Interpolation, Linear Interpolation, Nearest Neighbor Interpolation, Relative Percentage Error, and Prediction***

## I. INTRODUCTION

Climate analysis is long-term traits in meteorological phenomena. Data gaps, or missing data are regular problem and this problem frequently encountered in missing observations for time series data. Data that's recognized to place mistakenly can also be considered having missing values. Poor record keeping, misplaced files and uncooperative responses at some factor of data series will additionally lead to missing observations in the series. During this paper we choose Aurangabad district of Maharashtra for analysis of missing values. Aurangabad District also referred to as one of the 36 districts of Maharashtra state in western India. The local weather of the district is characterized by a hot summer and common dryness throughout the year barring throughout the south west monsoon season, which is from July to September while October and November constitutes the post monsoon season. In Aurangabad district, summer season continues from March to May and April and May month are the hottest months in year. In monsoon season, August month also have lowest maximum temperature. Winter runs from November until February and minimum temperature drops at some point of this times.

## II. LITERATURE REVIEW

Weather generators are computer algorithms that produce very long time series of weather variables that have statistical properties similar to those of present records. They have been largely used as a downscaling tool in climate change research [1-7]. Consequently, varied weather generators are developed over the past 3 decades, like WGEN [8-9], USCLIMATE [10], CLIGEN [11], ClimGen [12] and LARS-WG [13]. All of the weather generators presently accessible for provide a single scheme to generate every local climate variable. Users have little desire in choosing suitable choices for producing climate variables according to their particular study. Moreover, there is no scheme integrated into weather generators to deal with the established underestimation of inter-annual variability, even though several techniques have been introduced to deal with this problem [14-17]

## III.MATERIALS AND METHODS

Usually four strategies are used for local weather forecasting. This paper makes an indication of four interpolation strategies i.e. cubic, spline, Linear and Nearest Neighbor to visualize and predict the Maximum and Minimum Temperature records.

### *A. Data Collection and Retrieval*

Datasets used in this research were sourced from the publicly accessible records of the Indian Government from the year 1901 to 2002. The structure of data was in CSV format and included parameters like Maximum temperature and Minimum temperatures and these parameter has a numeric values.

### *B. Spline Interpolation*

Spline Interpolation can be defined as a one type of interpolation approach in which it is a different type of piecewise-polynomial and regularly referred to as a spline. Spline Interpolation is an Polynomial Interpolation Techniques. Spline interpolation also helps to avoid issues of Runge's phenomenon.

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### C. Cubic Interpolation

Cubic Interpolation is one form of interpolation methodology used for locating missing values or to interpolate between the lists of values. Using this method, a series of unique cubic polynomial are fitted between each of the data points, with the curve obtained to be continuous and appear smooth. This cubic method can then be used to determine rate of change and cumulative change over an interval. The curve consists of weight attached to flat surface at the point to be connected. The weights are the coefficient on the cubic polynomial used to interpolate the data.

### D. Nearest Neighbours Interpolation

Nearest-neighbour interpolation, also called as proximal interpolation or in some context, point sampling is a simple method of multivariate interpolation in one or more dimensions. This method is simplest method to interpolation rather than calculates an average value by some weighting criteria or generates an intermediate value based on complicated rules, this method simply determines the nearest neighbouring value.

### E. Linear Interpolation

Linear interpolation is that the simplest technique of obtaining values at positions in between the data points. It's technique of curve fitting exploitation linear polynomials. Linear interpolation works effectively drawing a line between 2 neighboring point and returning acceptable point on that line.

### F. Relative Error as a Measure of Accuracy

Accuracy refers to the difference between a measurement taken by measuring tool and actual value. The relative accuracy of a measurement can be expressed as percentage and these percentages can easy to calculate. Subtract the difference between the actual value and measurement from actual value and divide the result by the actual value to obtain the accuracy of the measurement. Multiply the result by 100 percent to convert the accuracy to a percentage.

## IV. RESULT AND ANALYSIS

As an estimation to approve the forecast value using four interpolation methods i.e. spline, cubic, Linear, Nearest Neighbours interpolation methods is utilized. Real-time circumstance is moreover made to analyze, where three months are made to be missing which is August, December, May and the misplaced data will be discovered by the using of the interpolation methods. Then the missing months records are compare to its actual value with the help of calculating the relative percentage error and the error rate that has a error much less than 20% is accept. For the forecast of missing values of Maximum temperature records of Aurangabad district, we pick out May, August, and December month from which, 1 August month, 1 months of January and 3 months of May have been left out i.e. complete 5 month from 1224 month to take out for the imputation of missing values by using of the utilization of interpolation methods. Similarly for the forecast of missing values of Minimum temperature records, we pick out May, August, and December month.

TABLE I
Analysis of missing Maximum Temperature data.

| Month No. | Month and Year | Actual Value | Cubic | Spline | Linear | Nearest |
|---|---|---|---|---|---|---|
| 173 | May-1915 | 39.85 | 38.01 | 39.22 | 37.58 | 36.64 |
| 356 | Aug-1930 | 29.17 | 29.91 | 28.26 | 30.18 | 30.81 |
| 533 | May-1945 | 39.65 | 36.97 | 37.77 | 36.42 | 35.14 |
| 720 | Dec-1960 | 31.09 | 30.69 | 30.55 | 30.69 | 31.05 |
| 893 | May-1975 | 39.62 | 38.53 | 39.32 | 37.46 | 34.14 |

Table II
Relative percentage error for missing maximum temperature data.

| Month and Year | Cubic | Spline | Linear | Nearest |
|---|---|---|---|---|
| May-1915 | 4.61 | 1.58 | 5.69 | 8.05 |
| Aug-1930 | 0.06 | 3.11 | 3.46 | 5.62 |
| May-1945 | 6.75 | 4.74 | 8.14 | 11.37 |
| Dec-1960 | 1.99 | 1.52 | 1.99 | 3.19 |
| May-1975 | 2.75 | 0.75 | 5.45 | 13.83 |

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Table III
Analysis of missing minimum temperature data.

| Month No. | Month and Year | Actual Value | Cubic | Spline | Linear | Nearest |
|---|---|---|---|---|---|---|
| 180 | Dec-1915 | 11.09 | 13.98 | 14.15 | 14.55 | 12.53 |
| 416 | Aug-1935 | 21.34 | 20.22 | 19.70 | 20.42 | 19.57 |
| 660 | Dec-1955 | 12.29 | 13.53 | 12.58 | 13.55 | 13.52 |
| 893 | May-1975 | 23.90 | 23.46 | 24.67 | 23.29 | 22.77 |
| 1140 | Dec-1995 | 14.70 | 15.38 | 14.94 | 15.73 | 14.94 |

Table IV
Relative percentage error for missing minimum temperature data.

| Month and Year | Cubic | Spline | Linear | Nearest |
|---|---|---|---|---|
| Dec-1915 | 17.47 | 18.90 | 20.2 | 5.29 |
| Aug-1935 | 5.24 | 7.68 | 4.31 | 8.29 |
| Dec-1955 | 10.28 | 2.35 | 10.26 | 10.00 |
| May-1975 | 1.88 | 3.22 | 2.55 | 4.72 |
| Dec-1995 | 4.62 | 1.63 | 7.08 | 1.63 |

## V. CONCLUSION

In this analysis work, four kinds of interpolation strategies i.e. cubic, Linear, Nearest Neighbours and Spline interpolation are investigated in detail for Maximum temperature and Minimum Temperature data. We test these techniques to interpolate the temperature data series of Aurangabad district for total 1224 months i.e. from Jan 1901 to Dec 2002. These techniques are capable to interpolates and provide the results. Firstly, the missing values in temperature series were neglected and then these neglected values within the temperature series were computed with the help of four differing types of Interpolation strategies. For the completion of the missing values, Cubic, Spline, Linear and Nearest Neighbours Interpolation technique had been used. The effects of estimation had been evaluated and decisions were made by analysing the Relative Percentage Error. The outcomes confirmed that the all four interpolation approach can be successfully utilized to entire the missing values in the temperature data series in Aurangabad district.

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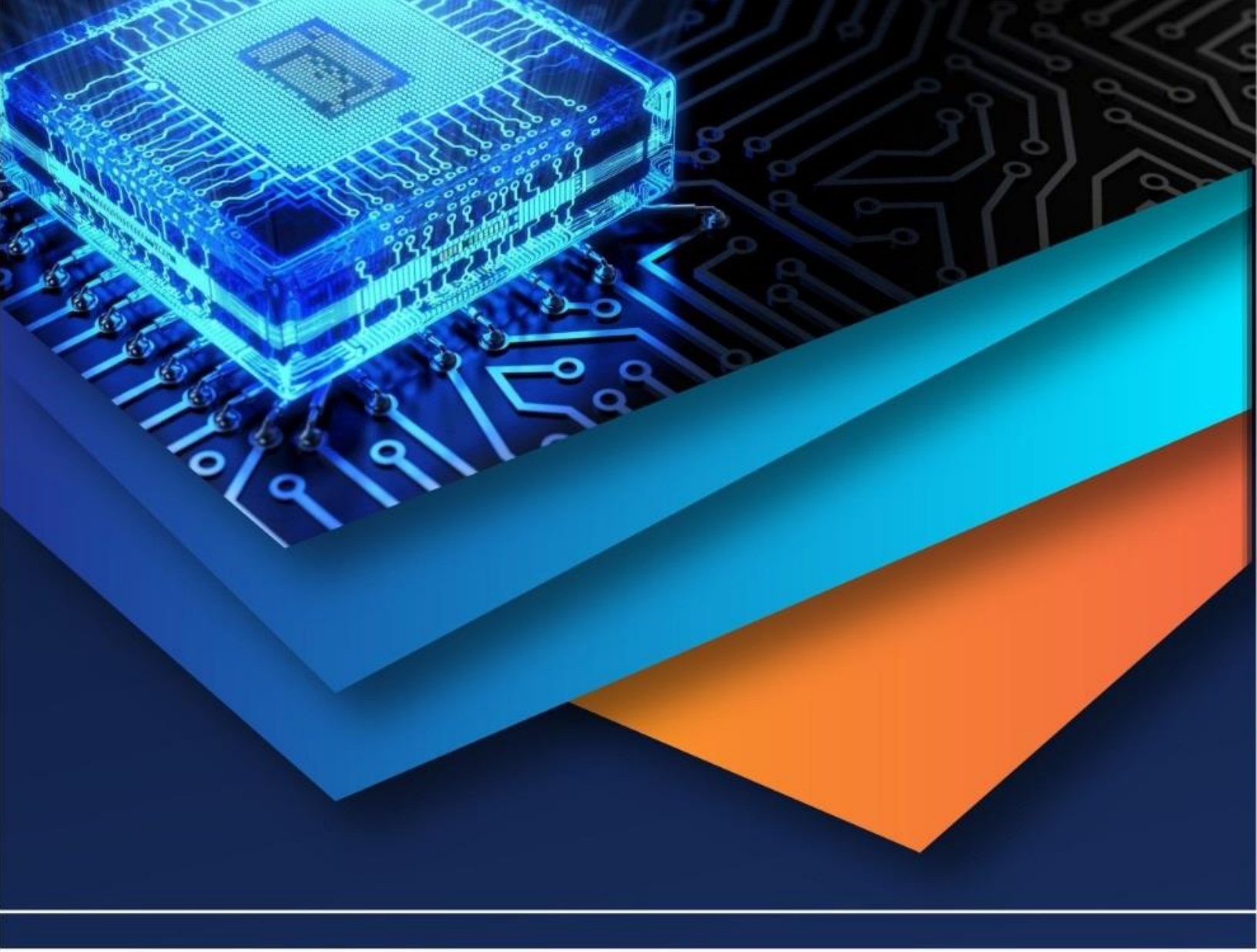

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