



Management of Climate Records using Interpolation Methods in Aurangabad District of Maharashtra state

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Abstract: This study makes a mention of two interpolation techniques i.e. cubic and spline to visualize and predict the precipitation and cloud covers data. The interpolation and the analysis of the precipitation and cloud cover data will be prepared on a monthly basis with the help of MATLAB software. The precipitation and cloud covers data is obtained from Indian water portal site for Aurangabad district from year 1901 to 2002. The interpolating curves, analysis of missing values and relative percentage error are then being compared and we talk about the missing data imputation by using both interpolation methods.

Key Words: Missing values, Cubic Interpolation, Spline Interpolation, Relative Percentage Error, and Prediction.

1. INTRODUCTION:

In our general public, we frequently need to dissect and make summarising's utilizing genuine information that is accessible for assortment. Preferably, we might want to believe that the information is painstakingly gathered and has standard examples without any anomalies or missing worth. Actually, this doesn't necessarily in every case occur, so a significant piece of the underlying assessment of the information is to evaluate the nature of the information and to consider adjustments where important. A typical issue that is regularly experienced is missing perceptions for time series information. Likewise, information that is known or thought to have been noticed incorrectly might be viewed as having missing qualities. Likewise, unfortunate record keeping, lost records and uncooperative reactions during information assortment will likewise prompt missing perceptions in the series. One of the vital stages in time series examination is to attempt to distinguish and address clear blunders and fill in any missing perceptions empowering thorough examination and anticipating. This can once in a while be accomplished utilizing basic strategies, for example, eyeballing, or computing suitable mean worth and so on. Notwithstanding, more intricate strategies might be required and they may likewise require a more profound comprehension of the time series information. We might need to endeavour to find the fundamental examples and irregularity. When we comprehend the idea of the information, we can handle the issue utilizing presence of mind joined with different numerical methodologies. This is both a workmanship and a science. Now and again, we are expected to gauge values past, or before, the scope of known values. To follow through with this responsibility effectively we want a model which sufficiently fits the accessible information in any event, when it is available to miss values. More complicated techniques for dissecting time series information will rely upon the kind of information that we are dealing with. In this paper we pick Aurangabad area for examination of missing worth attribution. Aurangabad Locale additionally called one of the 36 areas of Maharashtra state in western India. The environment of the region is portrayed by a blistering summer and general dryness all through the year besides during the south west storm season, which is from July to September while October and November comprises the post rainstorm season. In Aurangabad, the typical level of the sky covered by mists encounters outrageous occasional varieties throughout the span of the year. The clearer piece of the year in Aurangabad starts around October and finishing around the June. The cloudier part the year starts around June and finishing around October. On August the cloudiest month of the year, the sky is cloudy or for the most part shady 89% of the time, and clear, generally clear, or somewhat overcast 11% of the time. Consequently, we pick August month for overcast cover missing investigation. June, July, August, September are the Storm a long time for the city. Aurangabad notices moderate downpour during this period. The typical precipitation sum in the city is 588 mm during the season. July with a typical precipitation of 157 mm is the rainiest month for the city.



2. LITERATURE REVIEW:

Various scientists have put forth attempts to execute assorted procedures inside the scopes of meteorological information in light of climate information examination and figure. Meteorology information investigation has been actually used inside the field of making basic estimating applications.

A. Reynolds, 2017; overviews the environment is continually changing each time of months and unmistakable states have different measure of precipitation. These are because of the variables, for example, wind speed and wind bearing, the stickiness, the temperature (max, min and normal) in Malaysia. Because of this steady change, how much the precipitation should be recorded and gathered as they have tremendous effect on the climate, for example, the plants life, food and water supplies [1]. The series of information is finished by involving the Meteorology division in the particular states and this information then can be added with the goal that how much the precipitation for the following month can be determined and anticipated. This information is essential particularly to the ranchers and landscapers as they need to screen their plants during the planting and gathering seasons [1].

Consistently, Malaysia has gone through cool blustery downpour for every time of months and these effects the biological systems and individuals who depend on them like the ranchers and nursery workers. In this manner, a precipitation information checking is being done through the Meteorology division in every country with the goal that the precipitation still up in the air for a specific period. In this manner, the precipitation information got won't be uniform as Malaysia has its downpour season for specific term consistently. Various states will have unmistakable term because of the Upper East Storm causing weighty precipitation and the Southwest Rainstorm that causes blistering environment [2].

With respect to a model, the eastern coast provinces of Peninsular Malaysia, for example, Kelantan and western Sarawak will have a weighty precipitation because of this breeze season. Because of this consistent difference in climate, the precipitation information won't be uniform and to address this, the cubic spline addition is utilized for the mathematical examination. Cubic spline insertion is picked as its mistake edge is more modest and it offers a smoother interjection rather than the different introduction systems [3].

There are two limit expectations in cubic spline addition for example regular and not-a-tie. Karim et al. [4] had furthermore utilized direct, Piecewise Cubic Hermite adding Polynomial (PCHIP) and cubic spline introduction to add the petrol designing information.

Indeed, even albeit the PCHIP has lower request of coherence contrasted with the cubic spline, Abbas et al. [5] expressed that it is as yet helpful for some situation as its interjection worth will generally be positive. Work in this study is pertinent to the elective energy for example energy reaping from hydroelectric power that relies upon amount of the precipitation. The relevant association can utilize the proposed model to anticipate how much the precipitation amount at specific area.

Spline addition moreover evades issues of Runge's peculiarity (in which vacillation can occur between focuses while adding the use of over the top degree polynomials). Missing information is a colossal issue in Climate Expectation [6].

3. MATERIALS AND METHODS:

Usually two focal techniques are used for local weather forecasting, one includes practise of massive amount of data to get expertise about approaching local weather and the different includes development of equations that resource predict the climate away with the aid of the usage of identifying something else parameters and substituting values to get most wanted results. This paper makes an indication of two interpolation strategies i.e. cubic and spline to visualize and predict the precipitation and cloud covers data.

4. DATA COLLECTION AND RETRIEVAL:

Data used for the research work was obtained from Indianwaterportal.org site. The format of data was in CSV format and included parameters like precipitation and cloud cover. Analysis of important data was chosen and recovered from the dataset. Meteorological data set with properties, their type and depiction is displayed in Table 1.

Table 1: Numeric-Data Values Analysis

Attributes	Types	Descriptions
Years	Numeric	Considered Years
Months	Numeric	Considered Months
Precipitation	Numeric	Total-monthly-rainfall
Cloud Cover	Numeric	Total-monthly- Cloud Cover



Spline Insertion:

Spline Insertion can be characterized as a sort of introduction approach in which the interpolant is an alternate kind of piecewise-polynomial consistently alluded to as a spline. Little introduction mistakes are sure to seem when the utilization of low degree polynomials for the spline; for this reason, Spline Addition is in many cases preferred over Polynomial Addition Procedures. Spline addition likewise maintains a strategic distance from issues of Runge's peculiarity (where variance can appear between focuses while introducing utilizing serious level polynomials). Missing information is a monstrous issue in Climate Forecast. Subsequently climate information recovery frameworks utilize tantamount procedures to deal with missing information prior to utilizing the expectation models. In the proposed strategy Spline Addition procedure is utilized for managing missing information. Different various strategies were tried for something similar, yet Spline Insertion ended up being the most solid methodology of all.

Cubic Insertion:

Cubic Insertion is one as sort of introduction technique utilized for track down missing qualities or to interject between the arrangements of values. The key thought behind this technique depends on the designer's device used to draw smooth bend through number of focuses. Utilizing this technique, a progression of special cubic polynomial is fitted between every one of the useful pieces of information, with the limitation that the bend got be persistent and seems smooth. These cubic techniques can then be utilized to decide pace of progress and combined change over a stretch. The bend comprises of weight joined to level surface at the highlight be associated. The loads are the coefficient on the cubic polynomial used to add the information.

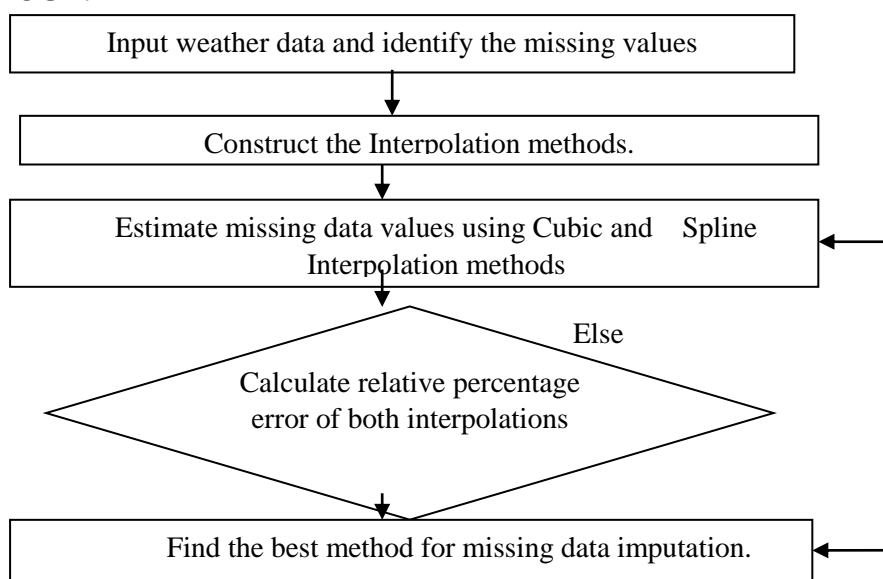
Relative Blunder as a Proportion of Precision:

It is the proportion of outright blunder of an estimation to estimation being taken. Precision alludes to the contrast between an estimation taken by estimating instrument and genuine worth. The general precision of estimation can be communicated as rate and these rates can simple to work out. Take away the distinction between the genuine worth and estimation from genuine worth and gap the outcome by the real worth to get the precision of the estimation. Duplicate the outcome by 100% to change the precision over completely to a rate.

The formula utilized for the relative percentage error is given as

$$\text{True relative percentage error} = \left| \frac{\text{Actual value} - \text{interpolation value}}{\text{Actual value}} \right| \times 100\%$$

5. METHODOLOGY:



6. RESULT AND ANALYSIS:

As an assessment to endorse the estimate esteem through utilizing two expansion methods for example spline and cubic presentation procedures is used. After we get the adding bend for the entire year-wise and month to month informational collections at Aurangabad locale from 1901 to 2002, we watched to find in the match that every limit conditions are sensible or not for the information in that particular month. Furthermore, constant situation is also made



to investigate the expansion where one month is made to be missing which is August and the lost missing information will be noticed utilizing the introduction. Then the missing month information is contrasted with its genuine worth by working out the general rate blunder and the mistake rate that has a mistake significantly less than 20% is acknowledge.

Precipitation Prediction:

Table 2. Analysis of missing precipitation data (Jan 1901-Dec 2002)

Month	Month and Year	Actual Value	Cubic	Spline
236	Aug-1920	42.06	78.15	93.96
476	Aug-1940	93.61	174.17	190.70
716	Aug-1960	93.60	194.88	233.39
956	Aug-1980	167.70	79.59	54.99
1196	Aug-2000	79.06	105.52	107.59

First column of the table no.2 indicates the particular month number in overall 102 years i.e. total 1224 month.

Table-3 Relative percentage error for precipitation data-

Month and Year	Cubic	Spline
Aug-1920	85.80	123.39
Aug-1940	86.05	103.71
Aug-1960	108.20	149.34
Aug-1980	52.54	67.20
Aug-2000	33.46	36.08

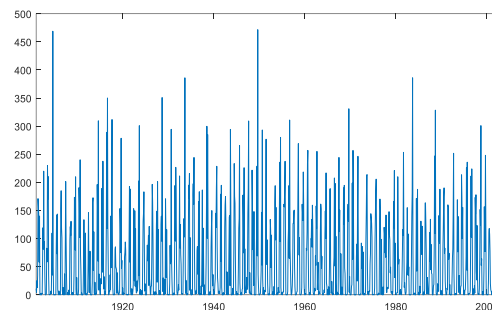


Figure 2. Spline interpolation of year wise precipitation data.

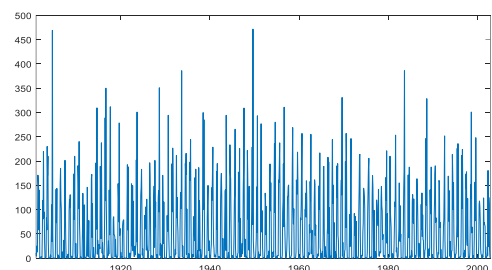


Figure 3. Cubic interpolation of year wise precipitation data.

In Figure 2 and figure 3, the interpolation for the precipitation data set both strategies have no issue since both values are positive and it is still inside the satisfactory run for a precipitation data type. In any case, the analysis on five lost months i.e. August-1920, August-1940, August-1960, August-1980 and August-2000 has appeared that the error percentage for the missing months is exceptionally high and usually not a great value as error percentage must be



at slightest below 20%. In this manner these interpolation techniques are not appropriate for imputation of missing precipitation data.

Cloud Covers prediction

Table 4. Analysis of missing cloud covers data (Jan 1901-Dec 2002)

Month No.	Month and Year	Actual value	Cubic	Spline
236	Aug-1920	78.45	75.31	82.22
476	Aug-1940	77.89	74.32	81.11
716	Aug-1960	79.47	76.12	82.75
956	Aug-1980	79.42	77.21	84.91
1196	Aug-2000	77.50	68.09	71.73

First column of the table no.4 indicates the particular month number in overall 102 years i.e. total 1224 month.

Table- 5 Relative percentage error for cloud covers data

Month and Year	Cubic	Spline
Aug-1920	4.00	4.80
Aug-1940	4.58	4.13
Aug-1960	4.21	4.12
Aug-1980	2.78	6.91
Aug-2000	12.14	7.44

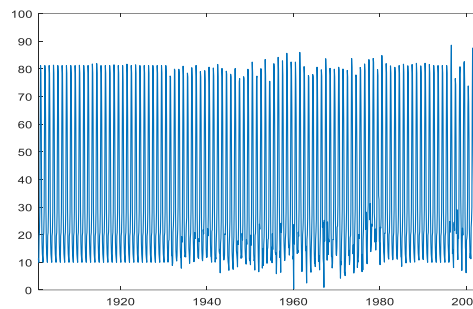


Figure 4.Cubic Interpolation of Cloud Covers Data

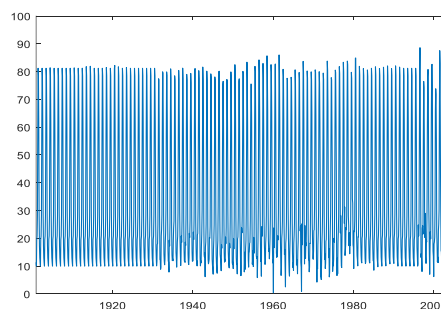


Figure 5.Spline Interpolation of Cloud Covers Data

Based on Fig.3 and 4, the values of the Cloud covers data from both interpolation methods are positive and they are still appropriate for the cloud cover data. Other than that, based on table 5, the error percentage for the five missing months i.e. August-1920, August-1940, August-1960, August-1980 and August-2000 is satisfactory as both techniques have an error less than 20%. Subsequently these interpolation methods are reasonable for imputation of missing cloud cover data.



7. CONCLUSION AND FUTURE WORK:

In this review, two sorts of addition systems for example cubic addition and spline introduction are researched exhaustively for precipitation and overcast covers information. We test these strategies to interject the precipitation and overcast covers insights of Aurangabad area for a considerable length of time for example from Jan 1901 to Dec 2002. The two strategies can introduce and give the outcomes. In any case, from table 3, the examination on missing months for example August has demonstrated that the mistake rate for the missing months is exceptionally unnecessary and this is definitely not a suitable worth as blunder rate should be to some degree under 20%. To tackle this issue, more noteworthy example focuses or day wise precipitation information might need to be added to limit the blunder rate and upgrade the precision of the forecast. The results show in this study can be also drawn out to the improvement of the great precision of the expectation based model. This will give the material office the adequate expectation model to gauge the climate information at specific area.

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