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Determination of Parameter from Observation Containing Itself and Chance Error: Central Tendency of Annual Extremum of Ambient air Temperature at Dibrugarh

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ABSTRACT: An analytical method has been developed, by Chakrabarty in 2014, for determining the true value of the parameter from observed data in the situation where the observations consist of a single parameter chance error but any assignable error. The method has already been successfully applied in determining the central tendency of each of annual maximum and annual minimum of the ambient air temperature at Guwahati. This paper deals with the determination of the central tendency of each of annual maximum and annual minimum of the ambient air temperature at Dibrugarh by the same method. The study has carried out using the data since 1969 onwards.

KEY WORDS: Ambient air temperature at Dibrugarh, central tendency, data with chance error, analytical method of determination

I. INTRODUCTION

Observations or data collected from experiments or survey suffer from chance error (which is unavoidable or uncontrollable) even if all the assignable (or intentional) causes or the sources of errors are controlled or eliminated and consequently the findings obtained by analyzing the observations or data which are free from the assignable errors are also subject to errors due to the presence of chance error in the observations [7]. Determination of parameters, in different situations, based on the observations is also subject to error due to the same reason. Searching for mathematical models describing the association of chance error with the observations is necessary for analyzing the errors. There are innumerable situations/forms corresponding to the scientific experiments. The simplest one is that where observations are composed of some parameter and chance errors ([7], [8] & [9]). The existing methods of estimation namely least squares method, maximum likelihood method, minimum variance unbiased method, method of moment and method of minimum chi-square ([1], [2], [3], [4], [5] &, [6]) provide the estimator of the parameter which suffers from some error. In other words, none of these methods can provide the true value of the parameter. However, An analytical method has been developed, by Chakrabarty [8] for determining the true value of the parameter from observed data in the situation where the observations consist of a single parameter chance error but any assignable error. The method has already been successfully applied in determining the central tendency of each of annual maximum and annual minimum of the ambient air temperature at Guwahati ([8] & [9]). This paper deals with the determination of the central tendency of each of annual maximum and annual minimum of the ambient air temperature at Dibrugarh by the same method. The study has carried out using the data since 1969 onwards.

II. THE METHOD

Let

$$X_1 , X_2 , \dots\dots\dots\dots , X_n$$

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be n observations on the annual maximum (or minimum) of the ambient air temperature at a location with central tendency μ.

In this situation, each observation X_i is composed of μ and chance error ε_i [10].

The method determining the value of the central tendency μ, developed by Chakrabarty [8] consists of the following steps:

Step-1:

Arranged the observations in ascending order of magnitude as

$$X_{(1)} < X_{(2)} < \dots\dots\dots < X_{(n)} \qquad (2.1)$$

Step-2:

Construct the averages

$$\bar{X}_{(i)}(1) = (n-1)^{-1} \sum_{j=1, j\neq i}^{n} X_{(j)} \qquad (2.2)$$
$$(i = 1, 2, \dots\dots\dots, n)$$

Step-3:

Take the interval

$$\bar{X}_{(n)}(1) < \mu < \bar{X}_{(1)}(1) \qquad (2.3)$$

as the first interval of μ.

Step-4:

Exclude the two extreme values namely $X_{(1)}$ & $X_{(n)}$ and construct

$$\bar{X}_{(i)}(2) = (n-3)^{-1} \sum_{j=2, j\neq i}^{n-1} X_{(j)} \qquad (2.4)$$
$$(i = 2, \dots\dots\dots, n-1).$$

Step-5:

Take the interval

$$\bar{X}_{(n-1)}(2) < \mu < \bar{X}_{(2)}(2) \qquad (2.5)$$

as the second interval of μ.

Step-6:

Exclude the four extreme values namely $X_{(1)}, X_{(2)}, X_{(n-1)}$ & $X_{(n)}$ and construct

$$\bar{X}_{(i)}(3) = (n-5)^{-1} \sum_{j=3, j\neq i}^{n-2} X_{(j)} \qquad (2.6)$$
$$(i = 3, \dots\dots\dots, n-2),$$

Step-7:

Take the interval

$$\bar{X}_{(n-2)}(3) < \mu < \bar{X}_{(3)}(3) \qquad (2.7)$$

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as the third interval of μ.

Step-8:

Exclude the six extreme values namely $X_{(1)}$, $X_{(2)}$, $X_{(3)}$, $X_{(n-2)}$, $X_{(n-1)}$ & $X_{(n)}$ and construct

$$\bar{X}_{(i)}(4) = (n-5)^{-1} \sum_{j=4,\, j \neq i}^{n-3} X_{(j)} \qquad (2.8)$$

$$(i = 4 , \ldots\ldots\ldots , n-3)$$

Step-9:

Take the interval

$$\bar{X}_{(n-3)}(4) < \mu < \bar{X}_{(4)}(4) \qquad (2.9)$$

as the fourth interval of μ.

The process can be continued further if necessary.

From the intervals obtained, one can detect the point value of μ.

III. ANNUAL EXTREMUM OF AMBIENT AIR TEMPERATURE AT DIBRUGARH:

A. ANNUAL MAXIMUM

Data on annual maximum of the ambient air temperature at Dibrugarh, collected from the meteorological department of India, for the period from 1969 to 2013 have been presented in **Table – 1**. These have been arranged in ascending order of magnitude and presented in **Table – 2**.

TABLE – 1

Observed value of Annual Maximum Temperature at Dibrugarh (in Degree Celsius)

Year	Observed value	Year	Observed value	Year	Observed value	Year	Observed value
1969	36.5	1980	36.7	1991	36.2	2005	36.3
1970	35.9	1981	36.2	1992	36.8	2006	37.5
1971	35.9	1982	36.2	1993	NA	2007	37.2
1972	36.2	1983	36.1	1994	NA	2008	37.1
1973	36.6	1984	39.8	1995	NA	2009	37.6
1974	36.6	1985	35.6	1996	NA	2010	36.6
1975	36.5	1986	36.2	2000	36.3	2011	37.6
1976	35.5	1987	36.3	2001	37.5	2012	37.5

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1977	35.7	1988	38.3	2002	36.4	2013	38.1
1978	36.8	1989	36.6	2003	36.7		
1979	37.8	1990	36.2	2004	35.1		

TABLE – 2

Observed values of Annual Maximum Temperature at Dibrugarh in ascending order (in Degree Celsius)

Serial No	Observed value	Serial No	Observed value	Serial No	Observed value	Serial No	Observed value
1	35.1	7	36.2	13	36.8	19	38.1
2	35.5	8	36.3	14	37.1	20	38.3
3	35.6	9	36.4	15	37.2	21	39.8
4	35.7	10	36.5	16	37.5		
5	35.9	11	36.6	17	37.6		
6	36.1	12	36.7	18	37.8		

Determination of the Central Tendency

1. **INTERVAL VALUE BASED ON ALL DISTINCT OBSERVED VALUES**

TABLE – 3

Mean of all observed values excluding the corresponding one (in Degree Celsius)

Serial No	Observed value	Mean	Serial No	Observed value	Mean
1	35.1	36.885	12	36.7	36.805
2	35.5	36.865	13	36.8	36.8
3	35.6	36.86	14	37.1	36.785
4	35.7	36.855	15	37.2	36.78
5	35.9	36.845	16	37.5	36.765
6	36.1	36.835	17	37.6	36.76
7	36.2	36.83	18	37.8	36.75

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8	36.3	36.825	19	38.1	36.735
9	36.4	36.82	20	38.3	36.725
10	36.5	36.815	21	39.8	36.65
11	36.6	36.81			

From this table the interval value of the central tendency is found to be

(36. 65 Degree Celsius , 36.885 Degree Celsius) (3.1)

2. INTERVAL VALUE BASED ON ALL DISTINCT OBSERVED VALUES EXCLUDING THE TWO EXTREME OBSERVATIONS NAMELY THE 1ST & THE 21st ONES

TABLE – 4

Mean of all observed values excluding the corresponding one (in Degree Celsius)

Serial No	Observed value	Mean	Serial No	Observed value	Mean
1	35.1		12	36.7	36.7333
2	35.5	36.8	13	36.8	36.7278
3	35.6	36.7944	14	37.1	36.7111
4	35.7	36.7889	15	37.2	36.7056
5	35.9	36.7778	16	37.5	36.6889
6	36.1	36.7667	17	37.6	36.6833
7	36.2	36.7611	18	37.8	36.6722
8	36.3	36.7556	19	38.1	36.6556
9	36.4	36.75	20	38.3	36.6444
10	36.5	36.7444	21	39.8	
11	36.6	36.7389			

From this table the interval value of the central tendency is found to be

(36.6444 Degree Celsius , 36.8 Degree Celsius) (3.2)

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3. INTERVAL VALUE BASED ON ALL DISTINCT OBSERVED VALUES EXCLUDING THE FOUR EXTREME OBSERVATIONS NAMELY THE 1ST, 2ND, 20TH & THE 21ST ONES

TABLE – 5

Mean of all observed values excluding the corresponding one (in Degree Celsius)

Serial No	Observed value	Mean	Serial No	Observed value	Mean
1	35.1		12	36.7	36.7125
2	35.5		13	36.8	36.70625
3	35.6	36.7815	14	37.1	36.6875
4	35.7	36.775	15	37.2	36.68125
5	35.9	36.7625	16	37.5	36.6625
6	36.1	36.75	17	37.6	36.65625
7	36.2	36.74375	18	37.8	36.6437
8	36.3	36.7375	19	38.1	36.625
9	36.4	36.73125	20	38.3	
10	36.5	36.725	21	39.8	
11	36.6	36.71875			

From this table the interval value of the central tendency is found to be

(36.625 Degree Celsius , 36.7815 Degree Celsius) (3.3)

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4. INTERVAL VALUE BASED ON ALL DISTINCT OBSERVED VALUES EXCLUDING THE SIX EXTREME OBSERVATIONS NAMELY THE FIRST THREE & THE LAST THREE

TABLE – 6

Mean of all observed values excluding the corresponding one (in Degree Celsius)

Serial No	Observed value	Mean	Serial No	Observed value	Mean
1	35.1		12	36.7	36.6929
2	35.5		13	36.8	36.6857
3	35.6		14	37.1	36.6643
4	35.7	36.7643	15	37.2	36.6571
5	35.9	36.75	16	37.5	36.6357
6	36.1	36.7357	17	37.6	36.6286
7	36.2	36.7286	18	37.8	36.6143
8	36.3	36.7214	19	38.1	
9	36.4	36.7143	20	38.3	
10	36.5	36.7071	21	39.8	
11	36.6	36.7			

From this table the interval value of the central tendency is found to be

(36.6143 Degree Celsius , 36.7643 Degree Celsius) (3.4)

POINT VALUE : The above four intervals yields the shortest interval as

(36.65 Degree Celsius , 36.7643 Degree Celsius) (3.5)

which further implies that the value of the central tendency 36.7 Degree Celsius.

Thus the central tendency of annual maximum of the ambient air temperature at Dibrugarh, as the available data yield, is 36.7 Degree Celsius.

B. ANNUAL MINIMUM

Data on annual minimum of the ambient air temperature at Dibrugarh, collected from the meteorological department of India, for the period from 1969 to 2013 have been presented in **Table – 1** from {[6] & [7]}. These have been arranged in ascending order of magnitude and presented in **Table – 2**

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TABLE – 1

Observed value of Annual Minimum Temperature at Dibrugarh (in Degree Celsius)

Year no	Observed value	Calendar year, Month & Date of occurrence	Year no	Observed value	Calendar year ,Month & Date of occurrence
1	4.3	1969, December 28 & 1970 January 4	19	5.5	1987, December 30
2	6.0	1971, January 10	20	4.9	1989, January 14
3	5.1	1971, December 20	21	6.2	1990, January 4
4	5.7	1973, January 17	22	5.5(3)	1991, January 23
5	5.2	1974, January 5	23	4.6(2)	1992, December 4
6	4.6	1974, December 24	24	7.3	2001, January 13
7	5.3	1975, December 28	25	6.8	2001, December 26
8	4.1	1977, January 3	26	5.8	2003, January 17
9	5.2(2)	1978, January 13	27	6.1	2004, January 7
10	4.2	1979, January 9	28	7.0	2004, December 29
11	5.5	1979, December 24	29	7.8	2006, January 5 & 8
12	6.3	1981,January 19	30	6.7	2007, January 19
13	6.3(2)	1982, February 10	31	7.6	2008, February 2
14	3.4	1983,January 6	32	8.2	2009, January 4
15	5.2(3)	1983, December 18	33	8.6	2010, January 4, 6 &18
16	5.4	1984,December 28	34	6.2(2)	2011, January 18
17	5.7(2)	1986, January 21	35	6.6	2012, January 16
18	5.0	1987, January 7	36	6.5	2013, January 25

TABLE – 2

Observed value of Annual Minimum Temperature at Dibrugarh in ascending order (in Degree Celsius)

Serial No	Observed value	Serial No	Observed value	Serial No	Observed value	Serial No	Observed value
1	3.4	8	5.1	15	6.0	22	6.8
2	4.1	9	5.2	16	6.1	23	7.0

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3	4.2	10	5.3	17	6.1	24	7.3
4	4.3	11	5.4	18	6.3	25	7.6
5	4.6	12	5.5	19	6.5	26	7.8
6	4.9	13	5.7	20	6.6	27	8.2
7	5.0	14	5.8	21	6.7	28	8.6

Determination of the Central Tendency

1. INTERVAL VALUE BASED ON ALL DISTINCT OBSERVED VALUES

TABLE – 3

Mean of all observed values excluding the corresponding one (in Degree Celsius)

Serial No	Observed value	Mean	Serial No	Observed value	Mean	Serial No	Observed value	Mean
1	3.4	6.0296	11	5.4	5.9556	21	6.7	5.9074
2	4.1	6.0037	12	5.5	5.9519	22	6.8	5.9037
3	4.2	6.0000	13	5.7	5.9444	23	7.0	5.8963
4	4.3	5.9963	14	5.8	5.9407	24	7.3	5.8852
5	4.6	5.9852	15	6.0	5.9333	25	7.6	5.8741
6	4.9	5.9741	16	6.1	5.9296	26	7.8	5.8667
7	5.0	5.9704	17	6.1	5.9259	27	8.2	5.8519
8	5.1	5.9667	18	6.3	5.9222	28	8.6	5.8370
9	5.2	5.9630	19	6.5	5.9148			
10	5.3	5.9593	20	6.6	5.9111			

From this table the interval value of the central tendency is found to be

(5.8370 Degree Celsius , 6.0296 Degree Celsius) (3.6)

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1. INTERVAL VALUE BASED ON ALL DISTINCT OBSERVED VALUES EXCLUDING THE TWO EXTREME OBSERVATIONS NAMELY THE 1ST & THE 28TH ONES

TABLE – 4

Mean of all observed values excluding the corresponding one (in Degree Celsius)

Serial No	Observed value	Mean	Serial No	Observed value	Mean	Serial No	Observed value	Mean
1	3.4		11	5.4	5.952	21	6.7	5.900
2	4.1	6.004	12	5.5	5.948	22	6.8	5.896
3	4.2	6.000	13	5.7	5.940	23	7.0	5.888
4	4.3	5.996	14	5.8	5.936	24	7.3	5.876
5	4.6	5.984	15	6.0	5.928	25	7.6	5.864
6	4.9	5.972	15	6.1	5.924	26	7.8	5.856
7	5.0	5.968	17	6.1	5.920	27	8.2	5.84
8	5.1	5.964	18	6.3	5.916	28	8.6	
9	5.2	5.96	19	6.5	5.908			
10	5.3	5.956	20	6.6	5.904			

From this table the interval value of the central tendency is found to be

(5.84 Degree Celsius , 6.004 Degree Celsius) (3.7)

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2. INTERVAL VALUE BASED ON ALL DISTINCT OBSERVED VALUES EXCLUDING THE FOUR EXTREME OBSERVATIONS NAMELY THE 1ST, 2ND, 27TH & THE 28TH ONES

TABLE – 5

Mean of all observed values excluding the corresponding one (in Degree Celsius)

Serial No	Observed value	Mean	Serial No	Observed value	Mean	Serial No	Observed value	Mean
1	3.4		11	5.4	5.9348	21	6.7	5.8783
2	4.1		12	5.5	5.9304	22	6.8	5.8740
3	4.2	5.9870	13	5.7	5.9217	23	7.0	5.8652
4	4.3	5.9826	14	5.8	5.9174	24	7.3	5.8522
5	4.6	5.9696	15	6.0	5.9087	25	7.6	5.8391
6	4.9	5.9565	16	6.1	5.9043	26	7.8	5.8304
7	5.0	5.9522	17	6.1	5.9000	27	8.2	
8	5.1	5.9478	18	6.3	5.8957	28	8.6	
9	5.2	5.9435	19	6.5	5.8870			
10	5.3	5.9391	20	6.6	5.8826			

From this table the interval value of the central tendency is found to be

(5.8304 Degree Celsius , 5.9870 Degree Celsius) (3.8)

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2. INTERVAL VALUE BASED ON ALL DISTINCT OBSERVED VALUES EXCLUDING THE FOUR EXTREME OBSERVATIONS NAMELY THE FIRST THREE & THE LAST THREE

TABLE – 6

Mean of all observed values excluding the corresponding one (in Degree Celsius)

Serial No	Observed value	Mean	Serial No	Observed value	Mean	Serial No	Observed value	Mean
1	3.4		11	5.4	5.9286	21	6.7	5.8667
2	4.1		12	5.5	5.9238	22	6.8	5.8619
3	4.2		13	5.7	5.9143	23	7.0	5.8524
4	4.3	5.9810	14	5.8	5.9095	24	7.3	5.8381
5	4.6	5.9666	15	6.0	5.9	25	7.6	5.8238
6	4.9	5.9524	16	6.1	5.8952	26	7.8	
7	5.0	5.9476	17	6.1	5.8905	27	8.2	
8	5.1	5.9429	18	6.3	5.8857	28	8.6	
9	5.2	5.9381	19	6.5	5.8762			
10	5.3	5.9333	20	6.6	5.8714			

From this table the interval value of the central tendency is found to be

(5.8238 Degree Celsius , 5.9810 Degree Celsius) (3.9)

POINT VALUE : The above four intervals yields the shortest interval as

(5.84 Degree Celsius , 5.981 Degree Celsius) (3.10)

which further implies that the value of the central tendency 5.9 Degree Celsius.

Thus the central tendency of annual minimum of the ambient air temperature at Dibrugarh, as the available data yield, is 5.9 Degree Celsius.

IV. CONCLUSION

The existing statistical methods of estimation yield estimates which are not free from error.
However, the method developed by Chakrabarty [8] can yield the estimate which is free from error (i.e. exactly equal to the true value of the parameter). Thus the central tendency of annual minimum as well as annual minimum of the ambient air temperature at Dibrugarh, as the available data yield, can be taken as 36.7 Degree Celsius and 5.9 Degree Celsius respectively.

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The determination of these two is based on the assumption that the data recorded by the Indian Meteorological Department have been recorded correctly. If there is any error in recording the data, the determined value(s) will not be accurate.
The determination of these two is based on another assumption that the change in temperature at Dibrugarh during the period whose data have been used in computation has not been influenced by any assignable cause(s). If in this period, some assignable cause has influenced significantly on the change in temperature at this location, the findings are bound to be inaccurate.

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