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A Measure of Temperature Index with Application in the Scenario at Guwahati

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Abstract

In a recent study, an art was shown on how to apply Pythagorean geometric mean in finding a suitable measure of average relative change in a group of variables. This art has here been applied in deriving a formulation of temperature index, a measure of overall relative change in temperature over two different situations. The formulation has been applied, in this study, in estimating temperature index at Guwahat in order to get a picture of change in temperature over the last fifty years there. The findings of the study has shown that at Guwahati, the tendency of temperature has increased by 6.9% over the last 50 years. It can be recomendeed that there is necessity of initiating action on reducing the temperature at Guwahati by 2.7 degree celcius or a little bit more for the interest of controlling warming there.

Key Words: *Group of variables, relative change, measure, temperature index, change at Guwahati*

1. Introduction:

The change in temperature at a location over time, which occurs due to two types of causes namely assignable or controllable cause (or causes) and chance cause is insignificant if it occurs due to chance cause only while the change is significant if it occurs due to some assignable cause(s) in addition to change cause [Chakrabarty (2005 , 2011 , 2014*a* , 2014*b* , 2014*c*)]. There is necessity of determining whether the change occurs due to both the causes or due to the chance cause only because, the task of controlling the change arises only when the change occurs due to assignable cause (or causes). There had been several studies on identifying the

significance of change in temperature at a location/place as well as on its central tendency [Bordoloi & Chakrabarty (2015 , 2015 – 16 , 2018) , Bordoloi , Chakrabarty & Kashyap (2021) , Chakrabarty (2015*a* , 2015*b* , 2020*b*] and its confidence interval (also natural extremum) within a temperature periodic year [Bordoloi & Chakrabarty (2016 , 2017 ,) , Chakrabarty (2005 , 2011 , 2014*a* , 2014*b* , 2014*c* , 2015*a* , 2015*b* , 2020*b* , 2015 – 16) , Bordoloi , Chakrabarty & Kashyap (2017) , Chakrabarty & Gohain (2015)]. However, it is also essential to know the degree or amount of change in temperature at a location or at the glove over time. An attempt has here been made on this aspect of temperature. One concept namely "**Temperature Index**" has been introduced here in order to measure the change in temperature at a location over time. Attempt has been made on defining this concept with the help of the concept of **"Average"** [Bakker (2003) , Miguel (2016)] which is a single number taken as representative of a non-empty list of numbers (including a large set of numbers) and which describes any characteristic of an aggregate / population / class of individuals overall but not of an individual in the aggregate / population / class in particular.

Pythagoras, a legand in mathematics, defined the three most common averages namely arithmetic mean, geometric mean and harmonic mean which were given the name "Pythagorean Means" as a mark of honour to him [Chakrabarty (2016 , 2019*a* , 2021*a* , 2021*a*)]. Later on, a number of definitions / formulations of average had been derived due to necessity of handling different situations. Some of them are quadratic mean or root mean square, square root mean , cubic mean, cube root mean, generalized p *mean* & generalized p^{th} root mean etc. in addition to Arithmetic Mean , Geometric Mean & Harmonic Mean [Chakrabarty (2016 , 2017 , 2018 , 2019*a* , 2019*b* , 2019*c* , 2020*a* , 2021*a* , 2021*b*) , Coggeshall (1886)]. Recently, four formulations of average have been derived from the three Pythagorean means which are Arithmetic-Geometric Mean, Arithmetic-Harmonic Mean, Geometric-Harmonic Mean and Arithmetic-Geometric-Harmonic respectively [Chakrabarty D. (2021*a*)].

In statistics, these three means are used in measuring the central tendency of data [Ali; Bhaskar, & Sudheesh (2019) , Argyrous (1997) , Argyrous (1997) , Fazli & Behboodian (2002) , Herbert

(1992) , Jain Sharad & Vijay (2019) , Manikandan (2011) , Weisberg (1992) , Williams (1984)]. Recently, it has been established that in addition to the the three Pythagorean means, the four formulations of average derived from them can also be used as mathematical measures of central tendency of data. [Chakrabarty (2021*c* , 2022)] which implies that average is a basis of mathematical measures of central tendency of data. Moreover, Pythagorean means can be hypothesized as a tool of constructing measures of various characteristics of data [Chakrabarty (2026)]. One common charqacteristic of data id addition to central is dispersion [Anderson & Finn (1996) , John (2024) , Kelly & James (1986) , Malakar (2023) , Moore (2010) , Murray & Larry (2018)]. Recently, it has been shown that average is also a basis of mathematical measures of dispersion of data [Chakrabarty (2024*b*)]. In another study, an art was shown on how to apply Pythagorean geometric mean, which carries a beautiful multiplicative property [Chakrabarty (2024*a*)] in finding a suitable measure of average relative change in a group of variables [Chakrabarty (2019*a*)]. This art has here been applied in deriving a formulation of **temperature index**, a measure of overall relative change in temperature over two different situations, in this study. The formulation has been applied in estimating temperature index at Guwahat in order to get a picture of change intemperature over the last fifty years there.

2. Change Index of A Group of Variabless:

Let

$$X_1 , X_1 , X_2 , X_2 , \ldots\ldots\ldots , X_n X_n$$

be n variables and

$$x_{1b} , x_{1b} , x_{2b} , x_{2b} , \ldots\ldots\ldots , x_{nb} x_{nb}$$

the values of the respective variables in the situation 'b'

as well as

$$x_{1c} , x_{1c} , x_{2c} , x_{2c} , \ldots\ldots\ldots , x_{nc} x_{nc}$$

the values of the respective variables in the situation 'c'.

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Let

$$k_1, k_1,\ k_2, k_2, \ldots\ldots\ldots, k_n\, k_n$$

be the relative changes of the values of the respective variables

$$X_1, X_1,\ X_2, X_2, \ldots\ldots\ldots, X_n\, X_n$$

from the situation 'b' to the situation 'c'.

This means,

$$x_{1c}\, x_{1c} = k_1\, k_1\, x_{1b}\, x_{1b},$$

$$x_{2c}\, x_{2c} = k_2\, k_2\, x_{2b}\, x_{2b},$$

$$\ldots\ldots\ldots\ldots\ldots\ldots,$$

$$x_{nc}\, x_{nc} = k_n\, k_n\, x_{nb}\, x_{nb}$$

This means,

$$k_1, k_1,\ k_2, k_2, \ldots\ldots\ldots, k_n\, k_n$$

are the respective multiples of

$$x_{1b}, x_{1b},\ x_{2b}, x_{2b}, \ldots\ldots\ldots, x_{nb}\, x_{nb}$$

such that $(k_1\, k_1\, x_{1b}\, x_{1b})(k_2\, k_2\, x_{2b}\, x_{2b}) \ldots\ldots\ldots (k_n\, k_n\, x_{nb}\, x_{nb}) = x_{1c}\, x_{1c}\, x_{2c}\, x_{2c} \ldots\ldots\ldots x_{nc}\, x_{nc}$

Now, if k is the overall multiple, equivalently overall relative change, which makes the values

$$x_{1b}, x_{1b},\ x_{2b}, x_{2b}, \ldots\ldots\ldots, x_{nb}\, x_{nb}$$

changed to to the respective values

$$x_{1c}, x_{1c},\ x_{2c}, x_{2c}, \ldots\ldots\ldots, x_{nc}\, x_{nc}$$

then $(k\, x_{1b}\, x_{1b})(k\, x_{2b}\, x_{2b}) \ldots\ldots\ldots (k\, x_{nb}\, x_{nb}) = (x_{1c}\, x_{1c}\, x_{2c}\, x_{2c} \ldots\ldots\ldots x_{nc}\, x_{nc})$

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or equivalently, $k\ (x_{1b}\, x_{1b}\, x_{2b}\, x_{2b}\ \ldots\ldots\ x_{nb}\, x_{nb}) = (x_{1c}\, x_{1c}\, x_{2c}\, x_{2c}\ \ldots\ldots\ x_{nc}\, x_{nc})$

which implies

$$k = \left\{ \frac{(x_{1c}\, x_{2c}\ \ldots\ldots\ x_{nc})}{(x_{1b}\, x_{2b}\ \ldots\ldots\ x_{nb})} \frac{(x_{1c}\, x_{2c}\ \ldots\ldots\ x_{nc})}{(x_{1b}\, x_{2b}\ \ldots\ldots\ x_{nb})} \right\}^{1/n}$$

(2.1)

Here,

$$k_1\, k_1 = \frac{x_{1c}}{x_{1b}} \frac{x_{1c}}{x_{1b}},\quad k_2\, k_2 = \frac{x_{2c}}{x_{2b}} \frac{x_{2c}}{x_{2b}},\quad \ldots\ldots\ldots\ldots,\quad k_n\, k_n = \frac{x_{nc}}{x_{nb}} \frac{x_{nc}}{x_{nb}}$$

can be interpreted as the relative changes (or change relative) of the respectively variables

$$X_1\, , X_1\, ,\ X_2\, , X_2\, ,\ \ldots\ldots\ldots\ldots,\ X_n\, X_n$$

in the situation 'c' with respect to the situation 'b'.

Therefore, the overall relative change k of the variables in the situation 'c' with respect to the situation 'b' can be defined as the geometric mean of the relative changes

$$\frac{x_{1c}}{x_{1b}} \frac{x_{1c}}{x_{1b}},\quad \frac{x_{2c}}{x_{2b}} \frac{x_{2c}}{x_{2b}},\quad \ldots\ldots\ldots\ldots,\quad \frac{x_{nc}}{x_{nb}} \frac{x_{nc}}{x_{nb}}$$

Note:

(1) The overall relative change k of the variables in the situation 'c' with respect to the situation 'b' can be termed as **Change Index** of the variables in the situation 'c' with respect to the situation 'b' .

Overall change in the variables can be interpreted as icreasing or decreasing according to the values of k is greater than 1 or less than 1.

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(2) Usually, index is expressed as percentage. Thus, 100 times of k can usually be used as **Change Index** of the variables. Usually therefore,

$$\text{Change Index} = \left\{ \frac{(x_{1c}\, x_{2c} \ldots\ldots\ldots x_{nc})}{(x_{1b}\, x_{2b} \ldots\ldots\ldots x_{nb})} \frac{(x_{1c}\, x_{2c} \ldots\ldots\ldots x_{nc})}{(x_{1b}\, x_{2b} \ldots\ldots\ldots x_{nb})} \right\}^{1/n} \times 100 \quad (2.2)$$

Overall change in the variables can be interpreted as icreasing or decreasing according to the values of Change Index is greater than 100 or less than 100.

3. Temperature Index – A Measure:

Now let os consider a characteristic of temperature at a place.

Suppose,

$$T_1, T_1, T_2, T_2, \ldots\ldots\ldots, T_n\, T_n$$

are n variables representing some characteristic of temperature at a place in a group of n period and

$$T_{1b}, T_{1b}, T_{2b}, T_{2b}, \ldots\ldots\ldots, T_{nb}\, T_{nb}$$

the values of the respective variables in the situation 'b'

as well as

$$T_{1c}, T_{1c}, T_{2c}, T_{2c}, \ldots\ldots\ldots, T_{nc}\, T_{nc}$$

the values of the respective variables in the situation 'c'.

Then the change index (describing the overall relative change) of these variables, which can be termed/interpreted as **Temperature Index**, in the situation 'c' with respect to the situation 'b' can be given by

$$\text{Temperature Index} = \left\{ \frac{(T_{1c}\, T_{2c} \ldots\ldots\ldots T_{nc})}{(T_{1b}\, T_{2b} \ldots\ldots\ldots T_{nb})} \frac{(T_{1c}\, T_{2c} \ldots\ldots\ldots T_{nc})}{(T_{1b}\, T_{2b} \ldots\ldots\ldots T_{nb})} \right\}^{1/n} \times 100$$

$= I_{bc}$, say (2.3)

4. Temperature Index at Guwahati:

The formulation of temperature index, descoibed above, has been applied in determining temaperature index of surface air temperature at Guwahati over the last 50 years. Maximum, Minimum & Median of temperature during a period of time can respectively describe/explain the highest level, the lowest leve & the tendency of warm in the period. Accordingly, monthy data on Maximum, Minimum & Median of temperature have been used in the study. **Table – 4.1**, **Table – 4.2** & **Table – 4.3** show maximum, minimum & median of surface air temperature at Guwahati (Borjhar) collected from

Indian Meteorological Department for the years 1973, 1983, 1993, 2003 & 2013

and from the website

AccuWeather https://www.accuweather.com › january-weather

for the year 2023.

Values of temperature index obtained by the application of the above formulation have been shown in **Table – 4.4** & **Table – 4.5**.

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Table – 4.1
(Maximum of Surface Air Temperature at Guwahati)

Month	Maximum Temperature (in Degree Celsius) in the Year					
	1973	1983	1993	2003	2013	2023
January	26.1	20.3	25.7	25.8	27.9	30

February	31.4	29.8	28.6	28.5	33.6	32
March	35.7	35.5	31.6	33.0	35.2	35
April	39.0	36.7	34.1	34.0	38.3	38
May	33.5	35.7	34.4	35.3	36.5	38
June	35.2	35.8	35.0	36.3	38.8	39
July	36.7	35.0	36.1	37.4	35.8	38
August	36.3	34.4	35.3	35.5	37.2	38
September	34.6	33.2	36.4	34.3	37.1	38
October	33.7	34.0	32.8	33.0	34.3	34
November	29.8	30.2	30.0	30.0	30.3	33
December	26.2	26.4	28.8	26.9	29.2	30

Table – 4.2
(Minimum of Surface Air Temperature at Guwahati)

Month	Minimum Temperature (in Degree Celsius) in the Year					
	1973	1983	1993	2003	2013	2023
January	7.0	4.9	8.5	8.0	5.6	9
February	5.0	5.3	8.4	9.9	9.4	9
March	12.0	11.6	12.8	10.5	15.3	14
April	17.0	13.2	14.7	17.5	17.1	17
May	20.3	17.8	19.8	18.0	19.6	20
June	23.4	21.3	22.0	22.5	23.0	22
July	23.5	23.9	24.2	24.9	24.5	25
August	23.9	22.9	24.2	24.8	24.5	25
September	23.3	22.5	22.8	24.2	22.0	23
October	17.8	18.2	19.6	26.4	18.2	19
November	12.4	12.2	13.4	14.7	12.0	14
December	9.5	8.1	7.8	9.9	8.2	10

Table – 4.3
(Median of Surface Air Temperature at Guwahati)

Month	Median Temperature (in Degree Celsius) in the Year					
	1973	1983	1993	2003	2013	2023
January	16.55	12.6	17.1	16.9	16.75	19.5

February	18.2	17.55	18.5	19.2	21.5	20.5
March	23.85	23.55	22.2	21.75	25.25	24.5
April	28	24.95	24.4	25.75	27.7	27.5
May	26.9	26.75	27.1	26.65	28.05	29
June	29.3	28.55	28.5	29.4	30.9	30.5
July	30.1	29.45	30.15	31.15	30.15	31.5
August	30.1	28.65	29.75	30.15	30.85	31.5
September	28.95	27.85	29.6	29.25	29.55	30.5
October	25.75	26.1	26.2	29.7	26.25	26.5
November	21.1	21.2	21.7	22.35	21.15	23.5
December	17.85	17.25	18.3	18.4	18.7	20

Table – 4.4

(Index of Surface Air Temperature at Guwahati with 1973 as Base Year)

Year	Temperature Index		
	Median Temperature	Maximum Temperature	Minimum Temperature
1983	96.7039	95,1668	91.81278
1993	99,1857	97.826	104.6232
2003	101.4218	98.0098	111.3575
2013	103.6902	1.042326	103.8726
2023	106.898	106.5522	110.9645

Table – 4.5

(Index of Surface Air Temperature at Guwahati with Preceding Year as Base Year)

Year (Base Year)	Temperature Index		
	Median Temperature	Maximum Temperature	Minimum Temperature
1983 (1973)	96.7039	95,1668	91.81278
1993 (1983)	102.5664	102.7943	113.9528
2003 (1993)	102.2545	100.1879	106.4367
2013 (2003)	102.2366	106.3491	93.2785
2023 (2013)	103.0936	102.2254	106.8275

4. Conclusion:

Temperature Index, defined by equation (2.3), is as follows:

The overall (average) change of temperature in the situation 'c' is

$$\frac{I_{bc}}{100}$$

times with respect to the temperature in the situation 'b' and the amount of that change is

$$(I_{bc} - 100)\%$$

The index of median temperature over the last 50 years has been found to be 106.898 which means, the change over this period is 6.898 % . Median is a measure of central tendency of data suitable to be used in data of continuous type [Ali; Bhaskar & Sudheesh (2019) , Malakar (2023) , Manikandan (2011)]. Accordingly, the findings on the index of median temperature implies that the tendency of surface air temperature at Guwahati has increased by 6.898 % over the last 50 years (from the year from 1973 to the year 2023).

Similarly the changes of maximum temperature and mimimum temperature over this period have been found to be 6.5522 % and 10.9645 % respectively. This implies that at Guwahati, the coldness of surface air has decreased by 10.9645 % while its hotness has increased by 6.5522 % over the last 50 years.

Findings also implies that maximum, minimum & median of temperature at Guwahati have increased by 2.5554 degree celcius, 2.7411 degree celcius & 2.1729 celcious respectively. Accordingly.

Each of Median, Maximum & Minimum of Temperature at Guwahati has been found to be decreasing during the decade 1973 – 1983 though found increasing over the last 50 years (1973 – 2023). This is so because of the monotonic increasing trend of each of them from the year 1983 onwards.

Finally on the basis of the findings obtained, it can be concluded that there is necessity of initiating action on reducing the temperature at Guwahati by 2.7 degree celcius or a little bit more for the interest of restoring the warming level at what was 50 years ago.

References:

Ali Zulfiqar; Bhaskar, S Bala & Sudheesh K (2019), Descriptive Statistics: Measures of Central Tendency, Dispersion, Correlation and Regression, *Airway*, 2(3), 120 – 125. DOI: 10.4103/ARWY.ARWY_37_19 .

Anderson T. W. & Finn J. D. (1996), Measures of Variability. In: The New Statistical Analysis of Data, Springer, New York, NY. https://doi.org/10.1007/978-1-4612-4000-6_4 .

Argyrous G. (1997), Measures of Central Tendency and Measures of Dispersion, *In: Statistics for Social Research*, Palgrave, London. https://doi.org/10.1007/978-1-349-14777-9_4 .

Bakker Arthur (2003), The Early History of Average Values and Implications for Education", *Journal of Statistics Education*, 11(1), 17 – 26.

Bordoloi R. S. & Chakrabarty D. (2015), Central Tendency of Annual Extremum of Ambient Air Temperature at Tezpur Based on Midrange and Median, *J. Chem. Bio. Phy. Sci*., Sec. C, 5(4), 4397 – 4410. www.jcbsc.org .

Bordoloi R. S. & Chakrabarty D. (2015 – 16), Annual Extremum of Ambient Air Temperature at Dibrugarh: Determination of Central Tendency, *J. Chem. Bio. Phy. Sci.*, Sec. C, 6(1), 212 – 233. www.jcbsc.org .

Bordoloi R. S. & Chakrabarty D. (2016), Confidence Interval of Annual Extremum of Ambient Air Temperature at Guwahati, *Journal of Mathematics and Systems*, 12(1–2), 55 – 62. www.abjni.com .

Bordoloi R. S. & Chakrabarty D. (2017), Confidence Interval of Annual Extremum of Ambient Air Temperature at Dibrugarh, *Aryabhatta Journal of Mathematics & Informatics*, 9(1), 85 – 94. www.abjni.com .

Bordoloi R. S. , Chakrabarty D. & Kashyap M. P. (2017), Confidence Interval of Annual Extremum of Ambient Air Temperature at Silchar, *International Journal of Advanced Research in Science, Engineering and Technology*, 4(11), 4868 – 4875. www.ijarset.com .

Bordoloi R. S. & Chakrabarty D. (2018), Central Tendency of Annual Extremum of Ambient Air Temperature at Dhubri, *Aryabhatta Journal of Mathematics & Informatics*, 10(1), 115 – 124. www.abjni.com .

Bordoloi R. S. , Chakrabarty D. & Kashyap M. P. (2021), Central Tendency of Annual Extremum of Ambient Air Temperature at Silchar, *Kalyan Bharati*, 37(IX), 32 – 45.

https://www.researchgate.net/publication/351618003_CENTRAL_TENDENCY_OF_ANNUAL_EXTREMUM_OF_AMBIENT_AIR_TEMPERATURE_AT_SILCHAR .

Chakrabarty D. (2005), Probabilistic Forecasting of Time Series, *Report of the UGC Awarded Post Doctoral Research Project* (2003 – 2005). DOI: 10.13140/RG.2.2.12952.98569.

Chakrabarty D. (2011), Determination of Natural Extrema of Temperature in the contest of Assam, *Report of the UGC Awarded Research Project* (2010 – 2011). DOI: 10.13140/RG.2.2.26374.75840 .

Chakrabarty D. (2014*a*), Temperature in Assam: Natural Extreme Value, *J. Chem. Bio. Phy. Sci.*, Sec. C, 4 (2), 1479 –1488. www.jcbsc.org .

Chakrabarty D. (2014*b*), Natural Interval of Monthly Extreme Temperature in the Context of Assam, *J. Chem. Bio. Phy. Sci.* Sec. C, 4 (3), 2424 –2433. www.jcbsc.org .

Chakrabarty D. (2014*c*), Statistical Method of Studying the Change in Climatic Component with Reference to Temperature in Assam, *National Seminar on* Social Issues and the Environment, held at Dakshin Kamrup College in collaboration with Indian Association of Physics Teachers, January 31– February 01. DOI: 10.13140/RG.2.2.22784.81923 .

Chakrabarty D. (2015*a*), Central Tendency of Annual Extremum of Surface Air Temperature at Guwahati, *J. Chem. Bio. Phy. Sci.*, Sec. C, 5(3), 2863 – 2877. www.jcbsc.org .

Chakrabarty D. (2015*b*), Central Tendency of Annual Extremum of Surface Air Temperature at Guwahati Based on Midrange and Median, *J. Chem. Bio. Phy. Sci.*, Sec. D, 5(3), 3193 – 3204. www.jcbsc.org .

Chakrabarty D. (2015 – 16), Confidence Interval of Annual Extremum of Ambient Air Temperature at Guwahati, *J. Chem. Bio. Phy. Sci.*, Sec. C, 6(1), 192 – 203. www.jcbsc.org .

Chakrabarty D. (2016): "Pythagorean Mean: Concept behind the Averages and Lot of Measures of Characteristics of Data", NaSAEAST- 2016, *Abstract ID: CMAST_NaSAEAST (Inv)-1601)*, 2016. DOI: 10.13140/RG.2.2.27022.57920 .

Chakrabarty D. (2017), Objectives and Philosophy behind the Construction of Different Types of Measures of Average, NaSAEAST- 2017, *Abstract ID: CMAST_NaSAEAST (Inv)- 1701.* DOI: 10.13140/RG.2.2.23858.17606 .

Chakrabarty D. (2018), General Technique of Defining Average, NaSAEAST- 2018, *Abstract ID: CMAST_NaSAEAST -1801 (I).* DOI: 10.13140/RG.2.2.22599.88481 .

Chakrabarty D. (2019*a*), Pythagorean Geometric Mean: Measure of Relative Change in a Group of Variables, NaSAEAST- 2019, *Abstract ID: CMAST_NaSAEAST-1902 (I)*. DOI: 10.13140/RG.2.2.29310.77124 .

Chakrabarty D. (2019*b*), One General Method of Defining Average: Derivation of Definitions/Formulations of Various Means, *Journal of Environmental Science, Computer Science and Engineering & Technology*, Sec. C, 8(4), 327 – 338, www.jecet.org .

Chakrabarty D. (2019*c*), A General Method of Defining Average of Function of a Set of Values, *Aryabhatta Journal of Mathematics & Informatics*, 11(2), 269 – 284. www.abjni.com .

Chakrabarty D. (2020*a*), Definition / Formulation of Average from First Principle, *Journal of Environmental Science, Computer Science and Engineering & Technology*, Sec C, 9(2), 151 – 163. www.jecet.org . DOI: 10.24214/jecet.C.9.2.15163.

Chakrabarty D. (2020*b*), Central Tendency of Annual Extremum of Surface Air Temperature at Guwahati by AGHM, *International Journal of Advanced Research in Science, Engineering and Technology*, 7(12), 16088 – 16098. www.ijarset.com .

Chakrabarty D. (2021*a*), Four Formulations of Average Derived from Pythagorean Means, *International Journal of Mathematics Trends and Technology*, 67(6), 97 – 118. http://www.ijmttjournal.org . doi:10.14445/22315373/IJMTT-V67I6P512 .

Chakrabarty D. (2021*b*), Recent Development on General Method of Defining Average: A Brief Outline, *International Journal of Advanced Research in Science, Engineering and Technology*, 8(8), 17947 – 17955. www.ijarset.com.

Chakrabarty D. (2021*c*), Measuremental Data: Seven Measures of Central Tendency, *International Journal of Electronics and Applied Research*, 8(1), 15 – 24. www.eses.net.in .

Chakrabarty D. (2022), AGM, AHM, GHM & AGH: Measures of Central Tendency of Data, *International Journal of Electronics and Applied Research*, 9(1), 1 – 26. http://eses.net.in/online_journal.html .

Chakrabarty D. (2024*a*), Beautiful Multiplicative Property of Geometric Expectation, *Partners Universal International Innovation Journal*, 02(02), 92 – 98. www.puiij.com . DOI: 10.5281/zenodo.10999414 .

Chakrabarty D. (2024*b*), Average: A Basis of Measures of Dispersion of Data, *International Journal of Advanced Research in Science, Engineering and Technology*, 11(7), 22053 – 22061. www.ijarset.com .

Chakrabarty D. & Gohain M. (2015), Application of Normal Probability Distribution in Estimating Annual Maximum and Minimum Temperature in the Context of Assam, *International Research Journal of Mathematics, Engineering & IT*, 2(3), 9 – 22. www.aarf.asia.

Coggeshall F. (1886), The Arithmetic, Geometric, and Harmonic Means, *The Quarterly Journal of Economics*, 1(1), 83−86. https://doi.org/10.2307/1883111 . https://www.jstor.org/stable/1883111 .

Fazli K. & Behboodian J. (2002), A Construction Method for Measures of Central Tendency and Dispersion, *International Journal of Mathematical Education in Science and Technology*, 33(2), 299 – 302. https://doi.org/10.1080/002073902753586409 .

Herbert F. Weisberg (1992), Central Tendency and Variability, Series: Quantitative Applications in the Social Sciences**"**, Issue 83, ", Chapter- 4, 46 − 75, Sage Publication, London**.**

Jain Sharad K. & Vijay P. Singh (2019), Key Statistical Measures of Data, Chap. 18.2 in *Engineering Hydrology: An Introduction to Processes, Analysis, and Modeling*, McGraw-Hill Education, New York. https://www.accessengineeringlibrary.com/content/book/9781259641978/toc-chapter/chapter18/section/section6 .

John H. Mc Donald (2024), Statistics of Dispersion, Sec 3.2, Statistics LibreTexts , https://stats.libretexts.org .

Kelly Ivan W. & James E. Beamer (1986), Central Tendency and Dispersion: The Essential Union, *The Mathematics Teacher*, 79(1), 59 – 65. *JSTOR*, http://www.jstor.org/stable/27964757.

Malakar I. M. (2023), Conceptualizing Central Tendency and Dispersion in Applied Statistics, *Cognition*, 5(1), 50 – 62. https://doi.org/10.3126/cognition.v5i1.55408 .

Manikandan S. (2011), Measures of Central Tendency: Median and mode, *Journal of Pharmacology and Pharmacotherapeutics*, 2(3), 214 – 215, 2011. DOI: 10.4103/0976-500X.83300 .

Miguel de Carvalho (2016), Mean, what do you Mean?, *The American Statistician*, , 70, 764 – 776.

Moore P. G. (2010), Principles of Statistical Techniques - Measures of Dispersion, Chapter-7, Cambridge University Press.

Murray R. Spiegel & Larry J. Stephens (2018), The Standard Deviation and Other Measures of Dispersion, In the book "*Schaum's Outline of Statistics*" Chapter-4, ISBN: 9781260011463, McGraw Hill. https://www.accessscience.com › chapter › chapter4.

Weisberg H. F. (1992), Central Tendency and Variability, *Sage University Paper Series on Quantitative Applications in the Social Sciences*, ISBN 0-8039-4007-6 pp.2.

Williams R. B. G.(1984), Measures of Central Tendency, *Introduction to Statistics for Geographers and Earth Scientist*, Soft cover ISBN978-0-333-35275-5, eBook ISBN978-1-349-06815-9 , Palgrave, London, 51 – 60.

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