Direct Research Journal of Engineering and Information Technology
Vol. 12 (2), Pp. 121-123, July 2024
ISSN: 2354-4155
DOI: https://doi.org/10.26765/DRJEIT8729330657
Article Number: DRJEIT8729330657

https://journals.directresearchpublisher.org/index.php/drjeit

Column Means of Matrices Formed from Odd and Even Sequential numbers

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Received 9 June 2024; Accepted 12 July 2024; Published 20 July 2024

ABSTRACT: In this paper, an equation is formulated to obtain the means of each column of any m×n matrix of sequential order, where r and c are row and column of the matrix respectively. The elements used here is a sequence of positive even numbers or positive odd numbers that start with 2 or 3 respectively. The number of rows and columns must be greater than or equal to 3. The number of columns c can be greater than or equal to the index value i representing the column mean for which mean is required. The result shows that given a matrix formed from sequence of positive odd numbers or positive even numbers, the mean of ith column of such matrix can be generated using the equations proposed in this work.

Keywords: Sequence, matrices, column means

Citation Akong,C. O., and Eyo, E. E.(2024). Column Means of Matrices formed from Odd and Even Sequential numbers. Direct Res. J. Eng. Inform. Tech. Vol. 12 (2), Pp. 121-123. https://doi.org/10.26765/DRJEIT8729330657

INTRODUCTION

Matrices has been widely employed in the world of mathematics and other fields of science. Matrices originated long ago in an attempt to solve systems of simultaneous linear equations by mathematicians. The study of matrix algebra first emerged in England in the mid – 1800s. The word matrix is Latin, and means womb and can also be used to refer to any place in which something is formed or produced. Matrix was first used in 1848 by James Joseph Sylvester while studying composition of linear transformations. The formalization of matrix theory started in 19th century (Gupta, 2022).

A matrix is a rectangular array of numbers. The numbers a_{ij} are called the elements of the matrix. An $(n \times 1)$ matrix is a column vector with n elements (Schmidheiny and Neusser, 2023). According to Rayate (2018), Matrices are two-dimensional arrangement of numbers in row(s) and column(s) enclosed by a pair of square brackets (Rayate, 2018). Matrices have been used to solve problems in areas like engineering, computing, statistics, economics, physics, data science etc. The mean is the average of a data set. The mean of a set of numbers in a data set is obtained by adding up all the numbers then dividing by the size of the data set (www.ncl.ac.uk). It is the most used measure of the centre of a set of data. It is also called average or arithmetic mean. The mean denotes equal distribution of values for a given data set. The arithmetic mean can also inform or model concepts outside of statistics. In a physical sense, the arithmetic mean can be thought of as a centre of gravity (www.byjus.com).

Assumptions

In this work, the following assumptions were made to satisfy the proposed equations:
Given that r and c are rows and column of sequential matrix of positive values, where r and c are greater than or equal to 3 ($r \,\&\, c \geq 3$).

The values in the matrices are odd integers arranged in sequential order starting from 1, 3, 5,…

The values in the matrices are even integers arranged in sequential order starting from 2, 4, 6, …

Proposed equation for column means of sequential matrices

Definition of terms

The mean of each column of any matrix is given as $\bar{X}^{i}_{r,c}$. Where r and c are number of rows and number of columns of the matrix and i is the column for which mean is required. c can be greater than or equal to i but i is not greater than c. The difference between two consecutive adjacent means in the same matrix is 2. That is

$$\bar{X}^{i+1}_{r,c} - \bar{X}^{i}_{r,c} = 2$$

The difference (d) between the first means of two consecutive opposite matrices is equal to 3. That is

$$d = \bar{X}^{1}_{r,c} \ \& \ \bar{X}^{1}_{r+1,c}$$

The difference d^{r} between the first means of two adjacent matrices is given as:

$$d^{r} = \bar{X}^{1}_{r,c+1} - \bar{X}^{1}_{r,c}$$

(it's constant for matrices with the same number of rows)

$$d^{r} = r - 1$$

for two consecutive matrices having 3 rows, $r = 3$, hence,

$$d_3 = 3 - 1 = 2.$$

for two consecutive matrices having 4 rows, $r = 4$, hence, $d_3 = 4 - 1 = 3$, etc.

$f^{i} = 2(i - 1)$ graduation factor

The proposed column means equation

$$\bar{X}^{i}_{r,c} = \bar{X}^{1}_{r,a} + d^{r}_{a,c} + f^{i}$$

where

$$\bar{X}^{1}_{r,a} = \bar{X}^{1}_{a,a} + d_{a,r}$$

$a = 3$ (Base value for both row and column of a 3X3 matrix)

$\bar{X}^{1}_{a,a} = 7$, for matrix of odd sequence

$\bar{X}^{1}_{a,a} = 8$, for matrix of even sequence
$d_{a,r} = (r - a)d$
$d = 3$ (Difference between mean of 1st column of two opposite matrices, $\bar{X}^{1}_{r,c}$ & $\bar{X}^{1}_{r+1,c}$)
$d^{r}_{a,c} = (c - a)d^{r}$
$d^{r} = r - 1$
$d^{r}_{a,c} = (c - a)(r - 1)$
$f^{i} = 2(i - 1)$

Application to matrices of sequence of odd positive numbers

Example 1:

Find the mean of the 1st column of a 6×8 matrix ($X_{6,8}$) having sequential odd numbers starting from 1, 3, 5...

Solution

The mean required is $\bar{X}^{1}_{6,8}$

$\bar{X}^{i}_{r,c} = \bar{X}^{1}_{r,a} + d^{r}_{a,c} + f^{i}$
Where $r = 6$, $c = 8$, $i = 1$, $a = 3$
$\bar{X}^{1}_{6,8} = \bar{X}^{1}_{6,3} + d^{6}_{3,8} + f^{1}$
$\bar{X}^{1}_{6,3} = \bar{X}^{1}_{3,3} + d_{3,6}$
$\bar{X}^{1}_{3,3} = 7$, for odd sequence
$d_{3,6} = (6 - 3)d = (6 - 3) \times 3 = 9$
$(d = 3)$
$\bar{X}^{1}_{6,3} = 7 + 9 = 16$
$d^{6}_{3,8} = (8 - 3)d^{6} = (8 - 3)(6 - 1) = 25$
$[d^{6} = (6 - 1)]$
$f^{1} = 2(1 - 1) = 0$
$\bar{X}^{1}_{6,8} = 16 + 25 + 0$
$\bar{X}^{1}_{6,8} = 41$

We can see that it was easy to obtain the mean since the rows and column of the ith value was relatively small, hence we can quickly draw the matrix and take the average of the tenth column to get the required mean. Now, suppose we are required to obtain the mean of 100th column of an 100000×2000 matrix of odd sequential order starting from 1, 3, 5,…, how easy would this be? This case is demonstrated in our second example and it is the beauty of this formula.

Example 2: find the mean of the 100th column of a 100000×2000 matrix having sequential odd numbers starting from 1, 3, 5,...

The mean required is $\bar{X}^{100}_{100000,\ 2000}$
$\bar{X}^{i}_{r,c} = \bar{X}^{1}_{r,a} + d^{r}_{a,c} + f^{i}$

Where $r = 100000$, $c = 2000$, $i = 100$, $a = 3$
$\bar{X}^{100}_{100000,\ 2000} = \bar{X}^{1}_{100000,\ 3} + d^{100000}_{3,\ 2000} + f^{100}$
$\bar{X}^{1}_{100000,\ 3} = \bar{X}^{1}_{3,3} + d_{3,100000}$

$\bar{X}^{1}_{3,3} = 7$ for odd series

$$d_{3,5} = (100000 - 3)d = (100000 - 3) \times 3 = 299991$$

$$\bar{X}^{1}_{100000,\ 3} = 7 + 299{,}991 = 299998$$

$\bar{X}^{1}_{100000,\ 3} = 299998$

$d^{100000}_{3,\ 2000} = (2000\ - 3)d^{100000}$

$[d^{100000} = (100000 - 1)]$

$d^{100000}_{3,\ 2000} = 1997(100000 - 1) = 199698003$
$f^{100} = 2(100 - 1) = 198$

$\bar{X}^{100}_{100000,\ 2000} = 299998 + 199698003 + 198$
$\bar{X}^{100}_{100000,\ 2000} = 199998199$

Application to matrices of sequence of even positive numbers

Example 2:

Find the mean of the 1st column of a 6×8 matrix having sequential even numbers starting from 2, 4, 6 ….

The mean required is $\bar{X}^{1}_{6,8}$

$\bar{X}^{i}_{r,c} = \bar{X}^{1}_{r,a} + d^{r}_{a,c} + f^{i}$
Where $r = 6$, $c = 8$, $i = 1$, $a = 3$
$\bar{X}^{1}_{6,8} = \bar{X}^{1}_{6,3} + d^{6}_{3,8} + f^{1}$
$\bar{X}^{1}_{6,3} = \bar{X}^{1}_{3,3} + d_{3,6}$
$\bar{X}^{1}_{3,3} = 8$ for even sequence
$d_{3,6} = (6 - 3)d = (6 - 3) \times 3 = 9$
$(d = 3)$
$\bar{X}^{1}_{6,3} = 8 + 9 = 17$
$d^{6}_{3,8} = (8 - 3)d^{6} = (8 - 3)(6 - 1) = 25$
$[d^{6} = (6 - 1)]$
$f^{1} = 2(1 - 1) = 0$
$\bar{X}^{1}_{6,8} = 17 + 25 + 0$
$\bar{X}^{1}_{6,8} = 42$

Conclusion

This work focused on getting a general equation for column means of matrices whose elements are sequence of positive whole numbers or positive odd numbers. The equation proposed in this work was subjected to several test and observed to work effective, thus reducing the burden of calculating columns of any such matrices by simply adding elements of the column and dividing by the frequency. This method is a faster approach of finding column means of sequential matrices.

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