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Row-Wise Representation of Arbitrary Rhotrix

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ABSTRACT : Mathematical arrays that are in some way between two-dimensional vectors and 2×2 dimensional matrices were suggested by Atanssor and Shannon [4].Ajibade [1] introduced the concept of rhotrix owing to some ideals he conceived of matrix – tertions and matrix – noitrets [2]. He identified a rhotrix as an object which is in some ways between a 2×2 dimensional matrix and 3×3 dimensional matrix.

Some Preliminary Concepts:

The axes of a rhotrix:

A vertical axis of a rhotrix is and arry of entries running from the top to the bottom of the rhotrix while a horizontal axis of a rhotrix is an array of entries running from the left to the right hand side of the rhotrix. This is the same as the diagonals in Ajibade [1]. Every rhotrix has a major vertical axis and a major horizontal axis. For example,

Consider the rhotrix

$$R_{5} = k \qquad \begin{array}{c} f & d & b \\ i & g & e \\ l & j & h \\ m \end{array} c$$
The vertical axes of R_{5} include:
$$\begin{array}{c} a \\ f & d \\ k, i \text{ and } g \\ j & j \\ m \end{array}$$
the last of the two lists.

The dimension of a rhotrix:

The dimension of a rhotrix is the number of entries in a major axis of the rhotrix. The dimension of a rhotrix is sometimes attached as a subscript to the variable used to indicate the rhotrix. For instance a rhotrix of the fifth dimension may be denoted as R_5

The rows and columns of a rhotrix:

The rows and columns of a rhotrix we follow the definitions of a row and a column of a 3 – dimensional rhotrix [5]. A row of a rhotrix is an array of entries running from the top – left to the right – bottom side of the rhotrix. A column of a rhotrix is an array of entries running from the top – right to the left – bottom side of the rhotrix.



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Vol. 4, Special Issue 13, December 2015

Heart – oriented multiplication of rhotrices:

Heart – oriented multiplication of rhotrices Ajibade [1] defined rhotrix multiplication '0' as follows, For any two rhotrices

$$R = b \quad \begin{array}{c} a \\ h(R) \\ e \end{array} d \quad and \quad Q = g \quad \begin{array}{c} f \\ h(Q) \\ k \end{array} j$$

$$ah(Q) + fh(R) \\ ah(Q) + gh(R) \quad h(R)h(Q) \quad dh(Q) + jh(R) \\ eh(Q) + kh(R) \end{array}$$

This form of rhotrix multiplication is called heart – oriented multiplication of rhotrices. Note that h(R) and h(Q) are the hearts of R and Q repectively.

Row – column multiplication of rhotrices:

Row – column multiplication of rhotrices sani [5, 6] defined row – column multiplication of 3-dimensional rhotrices as follows:

Let

$$A = \left\langle \begin{array}{c} a \\ c \\ e \end{array} \right\rangle b \quad and \ B = \left\langle \begin{array}{c} f \\ h \\ j \end{array} \right\rangle g$$

be two rhotrice of the third dimension . the row – column product '0' of A and B is expressed as /

$$A \circ B \neq df + ei \begin{array}{c} af + bi \\ ch \\ dg + ej \end{array} + bj$$

Row – column multiplication formula:

In the following theorem, we two rhotrices of the same dimension and represented in row – wise style of arbitrary rhotrices to devlope a formula for their row – column multiplication.

Theorem:

The row – column product $\langle c_{ij} \rangle$ of two rhotrices $\langle a_{ij} \rangle$ and $\langle b_{ij} \rangle$ of dimension d in row – wise form is established by the equation



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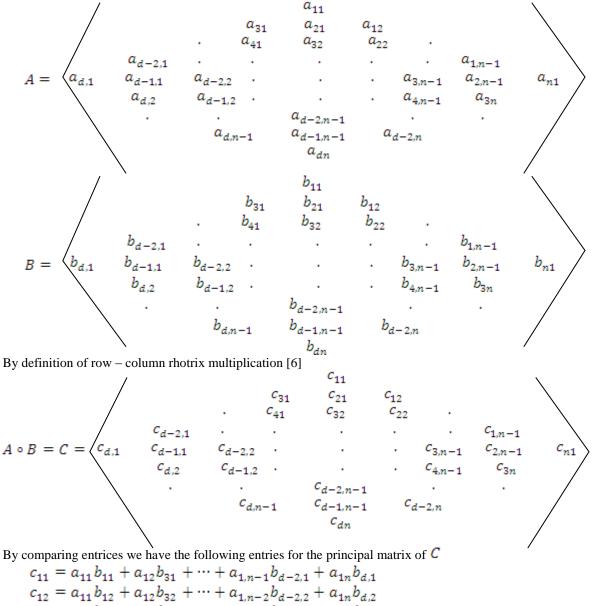
Vol. 4, Special Issue 13, December 2015

$$c_{ij} = \sum_{k=1}^{\frac{1}{2}[d-(-1)^{i}]} a_{i,k}b_{2k} - \frac{1}{2}[(-1)^{l+1} + 1].j$$

where $i = 1, 2, ..., d$ and $j = 1, 2, ..., \frac{1}{2}[d - (-1)^{i}].$

Proof:

Let d be an odd positive integer and let A and B denote the d dimensional rhotrices in row – wise form of arbitrary rhotrix representation as follows



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Vol. 4, Special Issue 13, December 2015

$$c_{32} = a_{31}b_{12} + a_{32}b_{32} + \dots + a_{3,n-1}b_{d-2,2} + a_{3n}b_{d,2}$$

 $\begin{array}{l} & \\ c_{d-2,n-1} = a_{d-2,1}b_{1,n-1} + a_{d-2,2}b_{3,n-1} + \cdots + a_{d-2,n-1}b_{d-2,n-1} + a_{d-2,n}b_{d,n-1} \\ c_{d-2,n} = a_{d-2,1}b_{1,n} + a_{d-2,2}b_{3n} + \cdots + a_{d-2,n-1}b_{d-2,n} + a_{d-2,n}b_{d,n} \\ c_{d,n-1} = a_{d,1}b_{1,n-1} + a_{d,2}b_{3,n-1} + \cdots + a_{d,n-1}b_{d-2,n-1} + a_{d,n}b_{d,n-1} \\ c_{d,n} = a_{d,1}b_{1,n} + a_{d,2}b_{3,n} + \cdots + a_{d,n-1}b_{d-2,n} + a_{d,n}b_{d,n} \end{array}$

Entries for the complementary matrix of C

Note that commas have been introduced between indices in the summations to avoid ambiguity. In move compact forms, we have,

Entries for the principal matrix of C

$$c_{11} = \sum_{\substack{k=1 \ n}}^{n} a_{1,k} b_{2k-1,1}$$

$$c_{12} = \sum_{\substack{k=1 \ n}}^{n} a_{1,k} b_{2k-1,2}$$

$$c_{31} = \sum_{\substack{k=1 \ n}}^{n} a_{3,k} b_{2k-1,1}$$

$$c_{32} = \sum_{\substack{k=1 \ n}}^{n} a_{3,k} b_{2k-1,2}$$

$$c_{d-2,n-1} = \sum_{\substack{k=1 \ n}}^{n} a_{d-2,k} b_{2k-1,n-1}$$

$$c_{d-2,n} = \sum_{\substack{k=1 \ n}}^{n} a_{d-2,k} b_{2k-1,n-1}$$

$$c_{d,n-1} = \sum_{\substack{k=1 \ n}}^{n} a_{d,k} b_{2k-1,n-1}$$

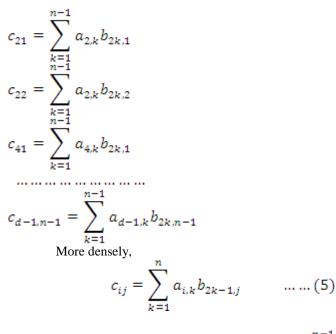
$$c_{d,n} = \sum_{\substack{k=1 \ n}}^{n} a_{d,k} b_{2k-1,n}$$

Entries for the complementary matrix of C:



(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 13, December 2015



(entries for the principal matrix of C)

$$c_{ij} = \sum_{k=1}^{n-1} a_{i,k} b_{2k,j} \qquad \dots \dots (6)$$

(entries for the complementary matrix of C)

The difference between the two summations above are the number of summands n and the first index 2k - 1 of b in (5) and the number of summands n - 1 and the first index 2k of b in (6). Now, i is odd and the first index for b is 2k - 1, for the entries in the principal matrix of C, while i is even and the first index for b is 2k - 0 (i.e. 2k) for the entries in the complementary matrix of C.

Consider the function

$$f(x) = \begin{cases} 1, & \text{if } x \text{ is odd} \\ 0, & \text{if } x \text{ is even}, \text{definded by } f(x) = \frac{1}{2} [(-1)^{x+1} + 1], x = 1, 2, \dots \end{cases}$$

Replacing 1 and 0 with $f(i)_n$ in the first index of b in (5) and (6) respectively, we have

$$c_{ij} = \sum_{k=1}^{n} a_{i,k} b_{2k - \frac{1}{2}[(-1)^{i+1} + 1],j} \qquad \dots \dots (7)$$

(entries for the principal matrix of C)

$$c_{ij} = \sum_{k=1}^{n-1} a_{i,k} b_{2k - \frac{1}{2}[(-1)^{i+1} + 1],j} \qquad \dots \dots (8)$$

(entries for the complementary matrix of C)

Again, consider the function

$$g(x) = \begin{cases} n, & \text{if } x \text{ is odd} \\ n-1, & \text{if } x \text{ is even} \end{cases} \text{definded by } g(x) = \frac{1}{2} [2n-1-(-1)^x] \\ x = 1, 2, \dots \end{cases}$$



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We replace with g(i) the only difference in (7) and (8), which are the total number of summands n and n-1, respectively, and obtain the single equation

$$c_{ij} = \sum_{k=1}^{\frac{1}{2}[2n-1-(-1)^{i}]} a_{i,k} b_{2k-\frac{1}{2}[(-1)^{i+1}+1],j}$$

where $i = 1, 2, ..., d_{and} j = 1, 2, ..., \frac{1}{2} [2n - 1 - (-1)^i].$

But *n* is the order of the principal matrix of *C*. Removing the entries of this matrix from *C* leaves us with the complementary matrix of *C* with order n - 1. By the second property in section 5, 2n - 1 = n + (n - 1) = d,

This gives the result

 $c_{ij} = \sum_{k=1}^{\frac{1}{2}[d-(-1)^{i}]} a_{i,k} b_{2k-\frac{1}{2}[(-1)^{i+1}+1],j}$ where i = 1, 2, ..., d and $j = 1, 2, ..., \frac{1}{2}[d-(-1)^{i}].$

CONCLUSION

In this dissertation, we present some methods of representing arbitrary rhotrices, of particular interest is the row – wise method with which we have established some formulae for rhotrix multiplication. The concepts of subrhotrix and submatrix of a rhotrix promises to pave way for a new dimension in describing various algebraic properties of rhotries.

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