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A New Heuris tic for Multiplication of two matrices of order 2*2

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Abstract— From the very beginning of computer era, the scientists are trying their best for searching the method which can reduce the complexity of multiplication of matrices. In case of ordinary matrix multiplication of two given 2*2 matrixes, we use three for loops to determine the product of these two matrixes and produce a resultant two-dimensional matrix. Then the complexity of the algorithm is n^3. Although this problem has been studying extensively, we intend to implement and modify the pre-existing procedure. So, we decide to tackle the multiplication of those two two-dimentional matrixes by using a one-dimensional array. The algorithm that we develop will store all the elements of two 2x2 matrixes in a single one-dimensional array. Then we generalized a formula that will provide the co-relationship between the index number of the one-dimensional array to find the product of those two 2*2 matrixes. So, in our case we determine the result by using two for loops only that basically reduce the complexity.

Keywords—matrix,multiplication,complexity, array.

I. INTRODUCTION

Matrix multiplication of two 2x2 matrix is done by using ordinary matrix multiplication process, that is basically done by taking one row of first matrix and one column of second matrix then we multiply the elements as per the sequence and add them together to get one element of the resultant matrix. If we want to do this task by implementing this algorithm of ordinary matrix multiplication in C language then it will be an iterative process that consists of three loops (one into another). And we have to take the elements of two arrays in two numbers of Two-dimensional arrays. In that case the complexity is order of n^3. So, to avoid programming complexity we are introducing a new method of matrix multiplication. In Our method we take two matrices as input in a one-dimensional array. Then we observe the co-relationship between the index number of the data element of one-dimensional array by comparing with the ordinary matrix multiplication. Then we generalize a basic formulation that also give the result of matrix multiplication but it takes only two loops (one into another) to determine the result. In that way we found a new methodology of matrix multiplication that would give the same result as the ordinary matrix multiplication but it to reduce the program complexity also.

The paper is consisting with the following sections. The proposed work is depicted in section 2. The illustrative example is tabled in section 3. Complexity analysis is in section 4. In section 5, the complexity of the proposed heuristic has been depicted. The conclusion and future scope are in section 6.

II. PROPOSED HEURISTIC

The proposed heuristic is used for multiplication of two matrices p and q of size 2*2 each. First, we take a matrix of size 2*2 and store them row-wise in the matrix A one by one. Then we take another matrix of size 2*2 and store them row-wise in matrix A after entering the numbers of the first matrix. In this way we create a one-dimensional matrix of size 1*8 from two two-mentional matrices p and q of size 2*2. After this, we create a resultant matrix C of size 2*2 from this one-dimensional matrix A. The resultant matrix C produces basically the result after multiplication of two matrices p and q.

Pseudo code:

I. Start

II. Let A [0….8] and C [0….4] be new arrays

III. m $\leftarrow$ Order of the matrix

IV. q $\leftarrow$ Total number of elements present in one 2x2 array

V. o ⟵ Total number of elements present in two 2x2 array

VI. "Taking first matrix"

VII. for i = 0 to m
  a. for j = 0 to m
    i. A[i*m+j] ⟵ new entered element by the user

VIII. "Taking second matrix"

IX. for i = 0 to m
  a. for j = 0 to m
    i. A[q+(i*m+j)] ⟵ new entered element by the user

X. k ⟵ 0

XI. for i = 0 to m with step i = i+2
  a. for j = (o/m) to ((o/m)+1)
    i. C[k] ⟵
    ii. A[i]*A[j]+A[i+1]*A[j+2];
    iii. k ⟵ k+1

XII. "printing the multiplication in matrix from"

XIII. for i = 0 to m
  a. for j = 0 to m
    i. print "C[i*m+j]"
    ii. print " "
  b. print "a new line"

XIV. Stop

III. FLOWCHART

Relevant details should be given including experimental design and the technique (s) used along with appropriate statistical methods used clearly along with the year of experimentation (field and laboratory). Figure 1 represents the flowchart for the proposed heuristic.

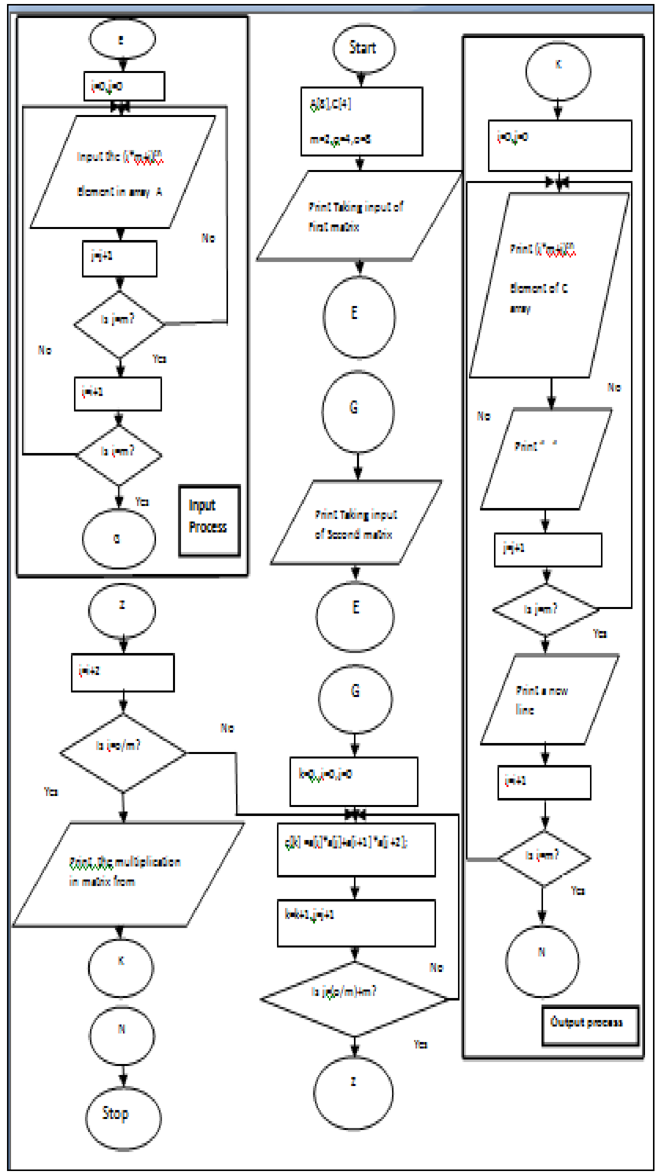

Figure 1: The flowchart of the heuristic

IV. ILLUSTRATIVE EXAMPLE

It is our first matrix: $\begin{pmatrix} a & b \\ c & d \end{pmatrix}$

It is our second matrix: $\begin{pmatrix} e & f \\ g & h \end{pmatrix}$

Let multiplications of these two matrixes are:

$\begin{pmatrix} w & x \\ y & z \end{pmatrix}$

If we store all the element of two matrixes in a single one-dimensional array:

Then it will look like:

Table1: Conversion of two two-dimentional matrices into one one-dimensional one.

Items	a	b	C	D	e	f	g	h
Position in the matrix	[0][0] of 1st matrix	[0][1] of 1st matrix	[1][0] of 1st matrix	[1][1] of 1st matrix	[0][0] of 2nd matrix	[0][1] of 2nd matrix	[1][0] of 2nd matrix	[1][1] of 2nd matrix
Position in the one dimensional array	0	1	2	3	4	5	6	7

Table 1 shows the Conversion of two two-dimentional matrices into one one-dimensional one.

This thing is achieved by a simple formula:
If we take a array of size 8 then
Let rows are denoted by r and columns are denoted by j the position of a element in matrix is denoted by [i][j]. let m = 2(order of 2x2 matrix)
Then first matrix we take by this formula:
Array [i*m+j] = [i][j]th element
Then second matrix we take by this formula:
Array [4+ (i*m+j)] = [i][j]th element
We are adding 4 in the second formula because first four place from 0 to 3 are taken by the first matrix. So by adding 4 we just put the element of the second matrix in the same array but after the element of first matrix.
Then we observe that:
W=0th element of the one dimensional array*4th element of the one dimensional+1th element of the one dimensional array*6th element of the one dimensional
X=0th element of the one dimensional array*5th element of the one dimensional+1th element of the one dimensional array*7th element of the one dimensional
Y=2th element of the one dimensional array*4th element of the one dimensional+3th element of the one dimensional array*6th element of the one dimensional
Z=2th element of the one dimensional array*5th element of the one dimensional+3th element of the one dimensional array*7th element of the one dimensional
This whole calculation is done by using two loops only and a formula:

i. c[k] $\leftarrow$ a[i]*a[j]+a[i+1]*a[j+2];
ii. k $\leftarrow$ k+1

C is a new array and k starts from 0. i starts from 0 and goes upto (o/2)[o=8=total number of element in two matrixes] with step length 2. j starts from (o/2) and goes upto (o/2)+2 with step length 1.Then we get the result in one dimensional array and print this in a matrix from by using the reverse process of the conversion of matrix to one dimensional array.

V. COMPLEXITY ANALYSIS

Total number of iteration is eight for ordinary matrix multiplication algorithm. Hence the complexity is n^3.
Here just four numbers of iteration occur. So the complexity of the proposed heuristic is n^2.

VI. SIMULATION RESULTS

The simulation work has been carried out in DEV C++ and using windows 10 operating system. The simulation work in figure 2 shows that the proposed heuristic is working properly with reduced complexity.

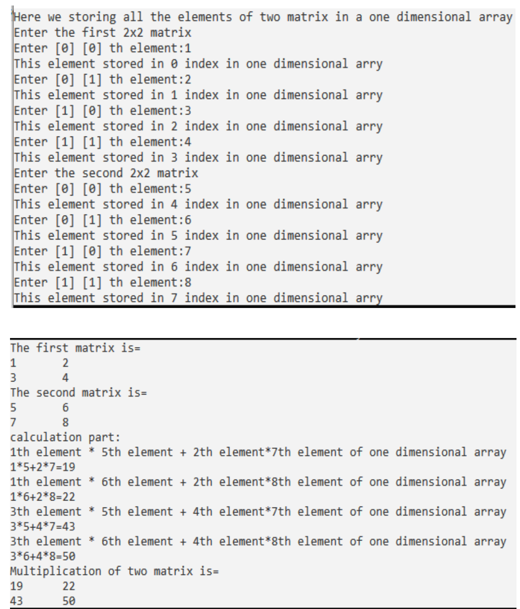

Figure2: The simulation work of proposed heuristic

VII. CONCLUSION AND FUTURE SCOPE

The complexity of ordinary matrix multiplication is n^3. The complexity of the Stressen's matrix multiplication is $n^{2.81}$. The complexity of the proposed heuristic for the multiplication of two 2*2 matrices is n^2. In future we can apply our heuristic to multiply two matrices of order m*n and n*r respectively.

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Mr Dharmpal Singh received his Bachelor of Computer Science and Engineering and Master of Computer Science and Engineering from West Bengal University of Technology. He has done his Ph.D in year 2015. He has about 12 years of experience in teaching and research. At present, he is with JIS College of Engineering, Kalyani, and West Bengal, India as an Associate Professor and Head of the department. He has published 32 papers in referred journal and conferences index by Scopus, DBLP and Google Scholar and editorial team and senior member of many reputed journal index by SCI, Scopus, DBLP and Google Scholar. He has organized seven national levels Seminar/Workshop, published two patent and has applied for the AICTE Research Project (MRP) in year of 2019.

