# DECUS
## PROGRAM LIBRARY

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| DECUS NO. | FOCAL8-91 |
| TITLE | MULTIPLICATION OF RECTANGULAR MATRICES |
| AUTHOR | Carl Bryant |
| COMPANY | Submitted by: Brother John F. O'Connell<br>St. John's Preparatory School<br>Danvers, Massachusetts |
| DATE | Submitted: April 21, 1970 |
| SOURCE LANGUAGE | FOCAL-69 |

# MULTIPLICATION OF RECTANGULAR MATRICES

DECUS Program Library Write-up

DECUS No. FOCAL8-91

## DESCRIPTION

The author of the SQUARE MATRIX MULTIPLY in DECUS FOCAL8-33 suggested that someone generalize the program to include multiplication of rectangular matrices. This is Carl Bryant's answer to the suggestion.

To use the program the matrices should be considered as square matrices using Ø for the missing elements. The dimensions x and y are entered according to the largest number of elements in any row or column of either matrix in the problem. Thus for

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix} \quad \text{and } B = \begin{bmatrix} 1 & 2 \\ 3 & 4 \\ 5 & 6 \end{bmatrix}$$ , enter x=3

and y = 3. The program will cause a : for nine entries for each matrix. Type in the given elements and Ø for any missing elements. The arrays will appear as follows:

| | | | | | |
|---|---|---|---|---|---|
| :1 | :2 | :3 | :1 | :2 | :Ø |
| :4 | :5 | :6 | :3 | :4 | :Ø |
| :Ø | :Ø | :Ø | :5 | :6 | :Ø |

The product A x B will appear in square form, but it can be interpreted as a rectangular matrix, if the user ignores any row or column that consists of all Ø's. The sample problems shown on the printout will make this more clear.

```
W A
C-FOCAL,1969

Ø1.Ø1    E
Ø1.1Ø    A       "DIMENSIONS",X,Y
Ø1.2Ø    F       I=1,X; F J=1,Y; A A(1Ø*I+J)
Ø1.3Ø    T       ! ; F I=1,Y; F J=1,X; A B(1Ø*I+J)
Ø1.35    S       I=Ø
Ø1.4Ø    S       I=I+1; S K=Ø; S P=Ø
Ø1.5Ø    S       K=K+1; F J=1,Y; S P=P+1; S C(P)=A(1Ø*I+J)*B(1Ø*J+K)
Ø1.6Ø    S       D(1Ø*I+K)=C(1)+C(2)+C(3)+C(4)+C(5)
Ø1.65    I       (<1Ø*I+K>-<1Ø*X+Y>) 1.7Ø, 1.75
Ø1.7Ø    I       (K-Y) 1.72, 1.4Ø
Ø1.72    S       P=Ø; G 1.5Ø
Ø1.75    S       P=Ø; S Q=Ø
01.76    T       !
Ø1.8Ø    S       P=P+1
Ø1.82    S       Q=Q+1
Ø1.83    I       (1-X) 1.85, 1.84
01.84    D       1.85; Q
Ø1.85    T       D(1Ø*P+Q)
01.87    I       (<1Ø*P+Q>-<1Ø*X+Y>) 1.9Ø; Q
Ø1.9Ø    I       (Q-Y) 1.82, 1.95
Ø1.95    T       ! ; S Q=Ø; G 1.8Ø

Ø2.1Ø    C       THE DIMENSIONS X AND Y SHOULD BE EQUIVALENT
Ø2.2Ø    C       TO THE LARGEST DIMENSION IN EITHER MATRIX
Ø2.3Ø    C       X SHOULD EQUAL Y TO GET THE PROPER DIMENSIONS
Ø2.4Ø    C       IN THE PRODUCT MATRIX
*


:Ø1.ØØ Ø1.2Ø
*GO
DIMENSIONS:4  :4
:1  :2  :3  :4                    A =  [1 2 3 4]
:Ø  :Ø  :Ø  :Ø
:Ø  :Ø  :Ø  :Ø
:Ø  :Ø  :Ø  :Ø

:1  :Ø  :Ø  :Ø                    B =  [1]
:2  :Ø  :Ø  :Ø                         [2]
:3  :Ø  :Ø  :Ø                         [3]
:4  :Ø  :Ø  :Ø                         [4]

3Ø  Ø  Ø  Ø                       A x B =  [30]
 Ø  Ø  Ø  Ø
 Ø  Ø  Ø  Ø
 Ø  Ø  Ø  Ø*
*
```

```
*GO
DIMENSIONS:4  :4
:1  :Ø  :Ø  :Ø
:2  :Ø  :Ø  :Ø
:3  :Ø  :Ø  :Ø
:4  :Ø  :Ø  :Ø

:1  :2  :3  :4
:Ø  :Ø  :Ø  :Ø
:Ø  :Ø  :Ø  :Ø
:Ø  :Ø  :Ø  :Ø

 1   2   3   4
 2   4   6   8
 3   6   9  12
 4   8  12  16*
*
```

$$A = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \end{bmatrix} \qquad B = \begin{bmatrix} 1 & 2 & 3 & 4 \end{bmatrix}$$

$$A \times B = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 2 & 4 & 6 & 8 \\ 3 & 6 & 9 & 12 \\ 4 & 8 & 12 & 16 \end{bmatrix}$$

```
*GO
DIMENSIONS:3  :3
:2  :3  :4
:-1  :-2  :Ø
:Ø  :Ø  :Ø

:4  :2  :Ø
:6  :1  :Ø
:3  :5  :Ø

 38  27  Ø
-16-  4  Ø
 Ø   Ø   Ø*
*
```

$$A = \begin{bmatrix} 2 & 3 & 4 \\ -1 & -2 & 0 \end{bmatrix} \qquad B = \begin{bmatrix} 4 & 2 \\ 6 & 1 \\ 3 & 5 \end{bmatrix}$$

$$A \times B = \begin{bmatrix} 38 & 27 \\ -16 & -4 \end{bmatrix}$$

```
*GO
DIMENSIONS:3  :3
:4  :2  :Ø
:6  :1  :Ø
:3  :5  :Ø

:2  :3  :4
:-1  :-2  :Ø
:Ø  :Ø  :Ø

 6   8  16
11  16  24
 1-  1  12*
*
```

$$A = \begin{bmatrix} 4 & 2 \\ 6 & 1 \\ 3 & 5 \end{bmatrix} \qquad B = \begin{bmatrix} 2 & 3 & 4 \\ -1 & -2 & 0 \end{bmatrix}$$

$$A \times B = \begin{bmatrix} 6 & 8 & 16 \\ 11 & 16 & 24 \\ 1 & -1 & 12 \end{bmatrix}$$

```
*GO
DIMENSIONS:4  :4
:4  :2  :Ø  :Ø
:1  :3  :Ø  :Ø
:Ø  :Ø  :Ø  :Ø
:Ø  :Ø  :Ø  :Ø

:1  :2  :3  :4
:Ø  :2   :-1  :6
:Ø  :Ø  :Ø  :Ø
:Ø  :Ø  :Ø  :Ø

4  12  1Ø  28
1   8   Ø  22
Ø   Ø   Ø   Ø
Ø   Ø   Ø   Ø *
*
```

$$A = \begin{bmatrix} 4 & 2 \\ 1 & 3 \end{bmatrix}$$

$$B = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 0 & 2 & -1 & 6 \end{bmatrix}$$

$$A \times B = \begin{bmatrix} 4 & 12 & 10 & 28 \\ 1 & 8 & 0 & 22 \end{bmatrix}$$