

## FW 364: Matrix Multiplication Into

Multiplying a matrix by a column vector yields a column vector (i.e., the result is a column vector, which I will call the results vector). To be able to multiply a matrix and a column vector, the number of columns in the matrix and the number of rows in the column vector must be equal. The results vector will always have the same number of rows as the number of rows in the matrix.

### Operation:

*Start with the first matrix row:*

Multiply the first element (i.e., element farthest to the left) in the first matrix row by the first element (i.e., top element) in the column vector, the second element in the first matrix row by the second element in the column vector, the third element in the first matrix row by the third element in the column vector, etc. Add these products together. The sum is the first element (i.e., top element) in the results vector.

*Continue with the second matrix row:*

Multiply the first element in the second matrix row by the first element in the column vector, the second element in the second matrix row by the second element in the column vector, the third element in the second matrix row by the third element in the column vector, etc. Add these products together. The sum is the second element in the results vector.

Repeat above process for all other rows in matrix.

$$\begin{vmatrix} A & B \\ C & D \end{vmatrix} * \begin{vmatrix} X \\ Y \end{vmatrix} = \begin{vmatrix} A*X + B*Y \\ C*X + D*Y \end{vmatrix}$$

$$\begin{vmatrix} 1 & 2 \\ 3 & 4 \end{vmatrix} * \begin{vmatrix} 100 \\ 10 \end{vmatrix} = \begin{vmatrix} 1*100 + 2*10 \\ 3*100 + 4*10 \end{vmatrix} = \begin{vmatrix} 120 \\ 340 \end{vmatrix}$$

$$\begin{vmatrix} A & B & C \\ D & E & F \\ G & H & I \end{vmatrix} * \begin{vmatrix} X \\ Y \\ Z \end{vmatrix} = \begin{vmatrix} A*X + B*Y + C*Z \\ D*X + E*Y + F*Z \\ G*X + H*Y + I*Z \end{vmatrix}$$

$$\begin{vmatrix} 1 & 3 & 5 \\ 2 & 4 & 6 \\ 7 & 7 & 7 \end{vmatrix} * \begin{vmatrix} X \\ Y \\ Z \end{vmatrix} = \begin{vmatrix} 1*X + 3*Y + 5*Z \\ 2*X + 4*Y + 6*Z \\ 7*X + 7*Y + 7*Z \end{vmatrix}$$

$$\begin{vmatrix} 1 & 2 & 4 \\ 4 & 5 & 7 \\ 7 & 8 & 0 \end{vmatrix} * \begin{vmatrix} 1 \\ 2 \\ 3 \end{vmatrix} = \begin{vmatrix} 1*1 + 2*2 + 4*3 \\ 4*1 + 5*2 + 7*3 \\ 7*1 + 8*2 + 0*3 \end{vmatrix} = \begin{vmatrix} 17 \\ 35 \\ 23 \end{vmatrix}$$

$$\begin{vmatrix} {}_0F & {}_1F & {}_2F & {}_3F \\ {}_0S & 0 & 0 & 0 \\ 0 & {}_1S & 0 & 0 \\ 0 & 0 & {}_2S & 0 \end{vmatrix} * \begin{vmatrix} {}_0N_t \\ {}_1N_t \\ {}_2N_t \\ {}_3N_t \end{vmatrix} = \begin{vmatrix} {}_0F*{}_0N_t + {}_1F*{}_1N_t + {}_2F*{}_2N_t + {}_3F*{}_3N_t \\ {}_0S*{}_0N_t \\ {}_1S*{}_1N_t \\ {}_2S*{}_2N_t \end{vmatrix}$$