Working With Matrices In Excel

As an illustration, we will work with the following system of equations

which can be written as the matrix equation

$$\begin{pmatrix} 2 & -2 & 1 \\ 3 & 1 & -1 \\ 1 & -3 & 2 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 3 \\ 7 \\ 0 \end{pmatrix}$$

Recall that in order to solve the matrix equation

 $A\mathbf{x}=\mathbf{b}$

(where A is a square matrix), we need only find the inverse (A^{-1}) of A (if it exists) and the solution will be given by

$$\mathbf{x} = A^{-1}\mathbf{b}$$

We will do all of the above in Excel.

When working with matrices in Excel, before you enter any kind of formula, press the F2 key (to tell Excel you are working with arrays), followed by the "=" sign.

The two built-in Excel functions we will use are as follows:

 $\begin{array}{ll} \mathbf{MMULT}(matrixA, matrixB) & \text{for finding the matrix product } AB \text{ (note the order)} \\ \mathbf{MINVERSE}(matrixA) & \text{for finding } A^{-1} \end{array}$

Consider our system above. Let

$$A = \begin{pmatrix} 2 & -2 & 1 \\ 3 & 1 & -1 \\ 1 & -3 & 2 \end{pmatrix} \qquad \qquad \mathbf{b} = \begin{pmatrix} 3 \\ 7 \\ 0 \end{pmatrix}$$

We need to find A^{-1} and the solution we are looking for is given by the matrix product $A^{-1}\mathbf{b}$.

Finding A^{-1}

Enter the numbers in A in any 3×3 cell block in Excel, putting each number in its own cell, in the rows and columns as they appear in A. (If your matrix is an $n \times n$ matrix, use an $n \times n$ cell block.

Since A^{-1} is a 3×3 matrix, select a 3×3 cell block anywhere else in your spreadsheet.

Perform the following steps (in the order given):

- Press the "F2" key.
- Press the "=" sign.
- Type in "MINVERSE(".
- Select the cells containing A^{-1} .
- Close the bracket ")". You should now have something that looks like the screen shot shown on the left below.
- Hold down the keys "**Ctrl**" and "**Shift**" at the same time and press the "**Enter**" key while holding down the other two.

 A^{-1} should now appear in the block of cells you had selected (see screen shot on the right below).

	A	В	C	D		A	В	C	D
1	2	-2	1		1	2	-2	1	
2	3	1	-1		2	3	1	-1	
3	1	-3	2		3	1	-3	2	
4					4				
5	=MINVERS	SE(A1:C3)			5	-0.5	0.5	0.5	
6		and the second			6	-3.5	1.5	2.5	
7					7	-5	2	4	
0		(a) (b)			0				

If something weird appears (like only one number appearing), you may have pressed the **Enter** key without holding down the **Ctrl** and **Shift** keys. If this is the case re-select the cells you had chosen for your A^{-1} and press the **Delete** key, then repeat the above steps.

If A^{-1} does not exist, e.g. the matrix $B = \begin{pmatrix} 2 & -4 \\ -3 & 6 \end{pmatrix}$ has no inverse since det(B) = 0, you make get something that looks like this:



Finding a matrix product AB

Suppose you want to find the product AB. You will first need to determine the order of the resulting matrix.

Suppose A is an $n \times m$ matrix and B is an $m \times p$ matrix. The order of AB is then $n \times p$.

To find AB in Excel, simply enter the numbers in the matrices anywhere on your spreadsheet. Perform the following steps:

- Select an empty $n \times p$ block of cells in your spreadsheet(if you know your matrix product is an $n \times p$ matrix).
- Press the "F2" key.
- Press the "=" sign.
- Type in "MMULT(".
- Select the cells containing A and enter a comma (,).
- Select the cells containing *B*.
- Close the bracket ")".
- Hold down the keys "**Ctrl**" and "**Shift**" at the same time and press the "**Enter**" key while holding down the other two.

As an illustration, let A be as given above and $C = \begin{pmatrix} 1 & 1 \\ 2 & 1 \\ 2 & 3 \end{pmatrix}$. Since A is a 3 × 3 matrix and C is a 3 × 2 matrix, the product AC is a 3 × 2 matrix. Performing the above steps will give the following screen shots:

	A	B	C	D	E	F	- 3
1	2	-2	1	1	1	1	
2	3	1	-1		2	1	
3	1	-3	2		2	3	
4							
5	=MMULT(A1	:C3,E1:F3)			1		
6						10	
7						10	
0		-	111				
	A	В	C	D	E	F	
1	2	-2	1		1	1	
2	3	1	-1		2	1	
3	1	-3	2		2	3	
4							
5	0	3	1			1	
6	3	1					
7	-1	4					
0							

We are now ready to find the solution to our system of equations.

Solving the system of Equations

Enter the right-hand-side column vector $\mathbf{b} = \begin{pmatrix} 3 \\ 7 \\ 0 \end{pmatrix}$ into a 3×1 block of cells in your spreadsheet. Also enter the matrix A into a 3×3 block of cells in your spreadsheet.

Since we will get the solution from the matrix product $A^{-1}\mathbf{b}$, we first determine the order of the resultant matrix. In this case, we are multiplying a 3×3 matrix by a 3×1 vector, we will get a 3×1 vector.

Select a 3×1 block of empty cells. Type the following: F2 = MMULT(MINVERSE(and select the cells containing matrix A. Close bracket). Type a comma and select the cells containing the vector **b** and close bracket). You should have something that looks like this:

	A	B	C	D	E
1	2	-2	1		T 3
2	3	1	-1		7
3	1	-3	2		0
4	2				
5	=	MMULT(MI	NVERSE(A1:C3),E	1:E3)
6					1
7		1			
0					

Hold down the **Ctrl** and **Shift** keys and press the **Enter** key while still holding the other two keys. The values of x, y and z should now appear (see screen shot below).

	A	B	C	D	E
1	2	-2	1		3
2	3	1	-1		7
3	1	-3	2		0
4					
5		2			
6		0			
7		-1			

Note that we did not have to calculate A^{-1} separately. We simply asked Excel to calculate it for us and then multiply the inverse by **b**. Most Excel functions can be nested in this way.