CGN 2420
Matrix Operations in Excel

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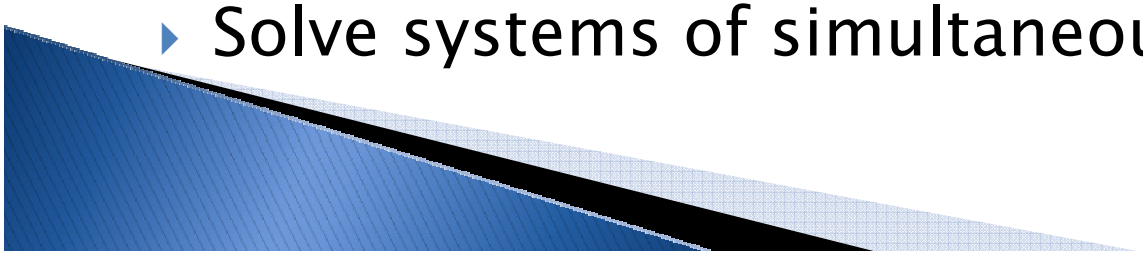
Objectives

- Learn how to define and name arrays.
- Learn how to carry out standard matrix math:
  - Multiplying matrices by scalar values.
  - Matrix addition.
  - Matrix multiplication.
  - Transposing matrices.
  - Inverting a matrix.
- Find the determinant of a matrix.
- Solve systems of simultaneous linear equations.



Defining and Naming Arrays

An array is defined by filling a range of cells with the contents of the array.

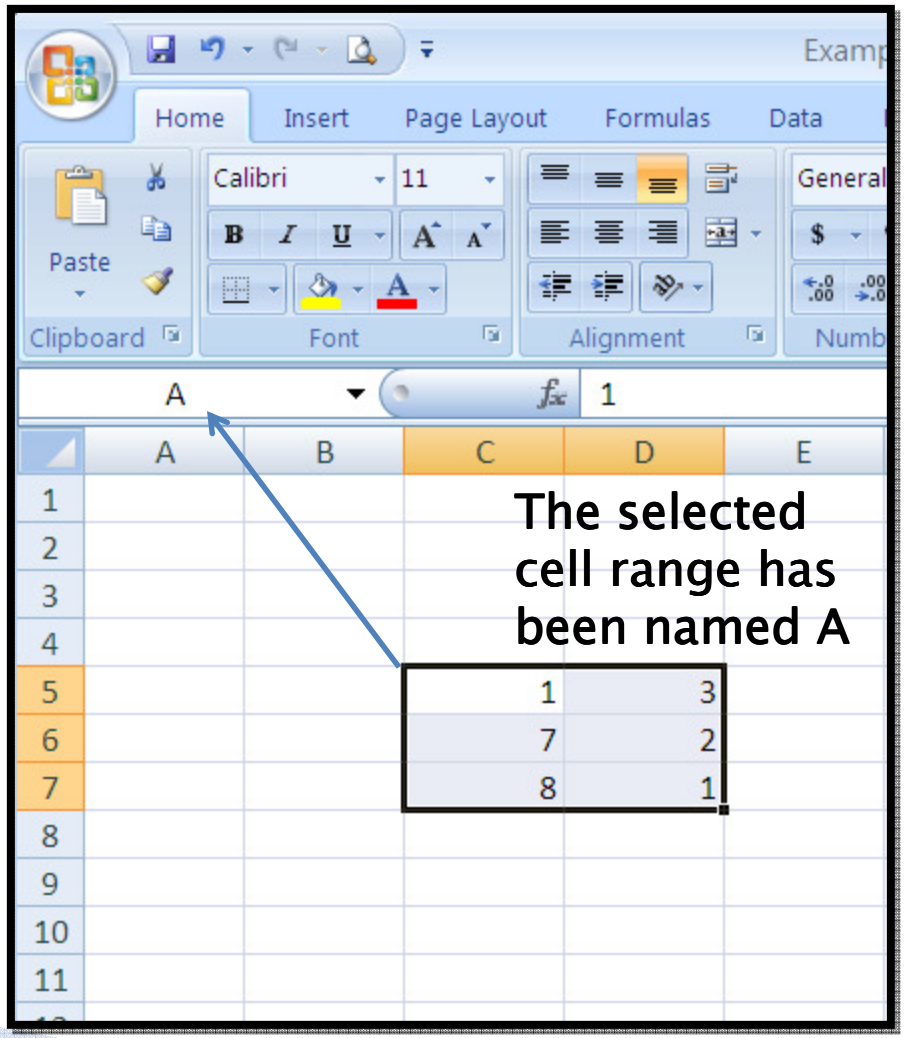
- Naming a range of cells allows you to use the name in place of the cell range.

- To give a name to the range of cells that hold an array:

  - Select the cells containing the array.
  - Enter the desired name in the name box at the left side of the formula bar.
  - Alternatively, a selected range can be assigned a name by using the ribbon options:

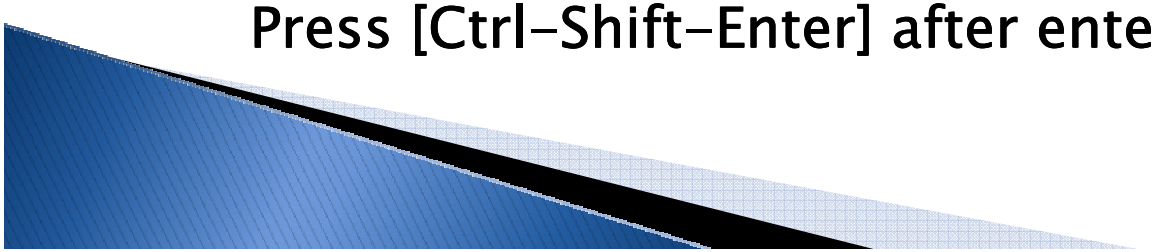
Formulas/Defined Names/Define Name

Defining and Naming Arrays (Cont.)

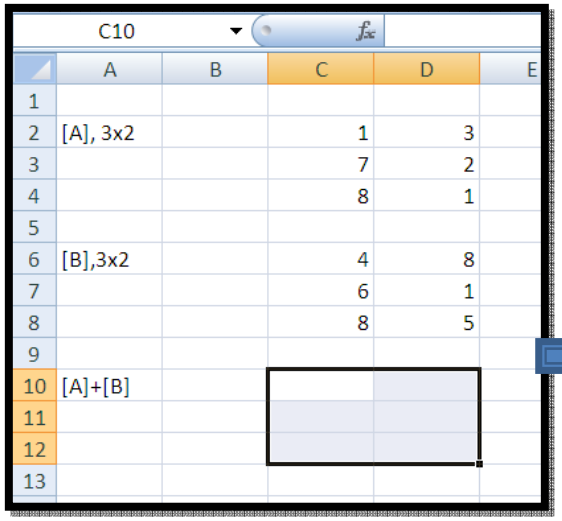


Matrix Addition

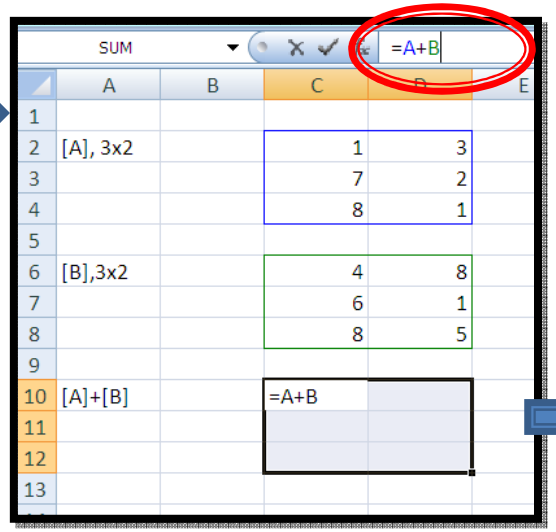
- The two matrices to be added must be the same size.
- Matrices can be added using basic cell arithmetic or array math operation.
- Matrix addition using array math:
  - Name the cell ranges containing the arrays that will be added.
  - Select a cell range with same dimensions as parent matrices.
  - Then enter the formula= name matrix 1+name matrix 2. **Press [Ctrl-Shift-Enter] after entering formula.**



Matrix Addition (Cont.)

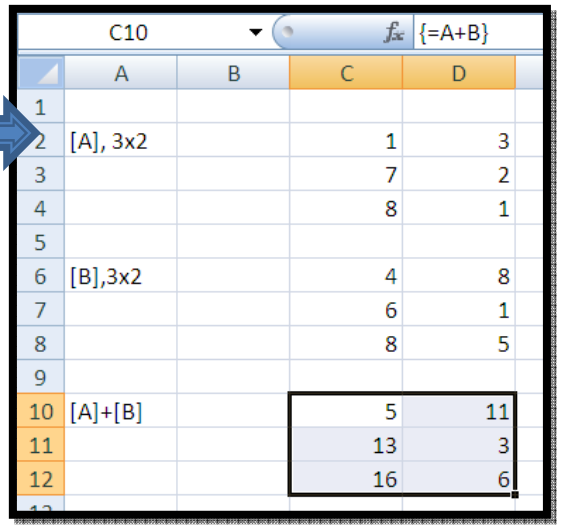


Select cell range



Enter Formula

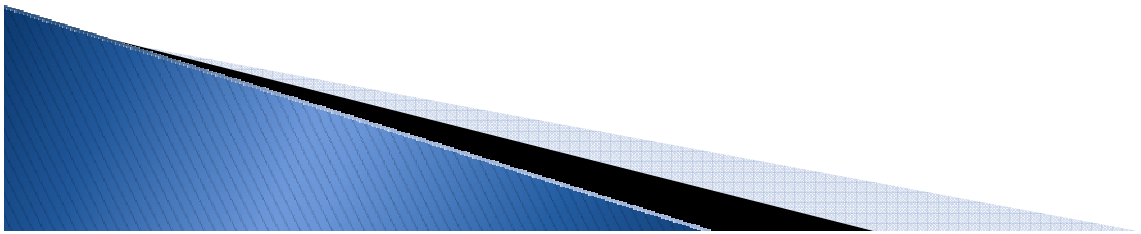
Important!
Press [Crtl-Shift-Enter] after entering formula



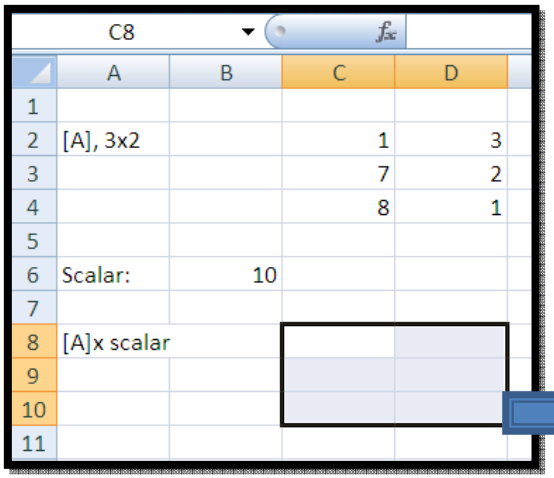
Multiplying a Matrix by a Scalar

Multiplying a matrix by a scalar requires to multiply each element of the matrix by the scalar.

- Scalar multiplication using array math:
  - Enter and name the array that will be multiplied.
  - Indicate the size of the result matrix by selecting the desired cell range.
  - Enter the formula + [Ctrl-Shift-Enter]

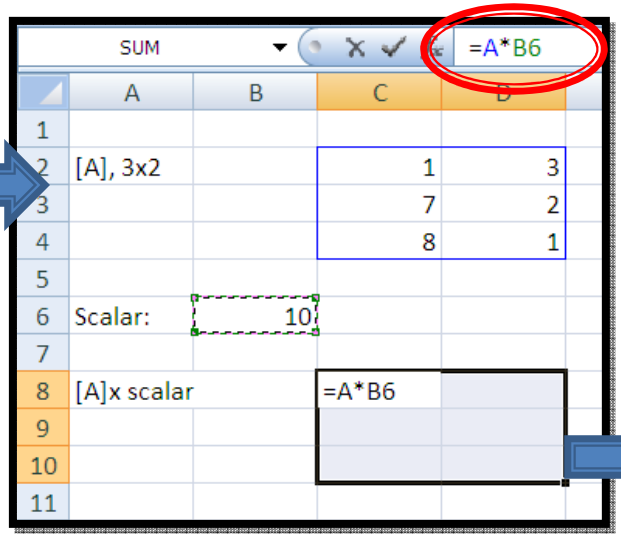


Multiplying a Matrix by a Scalar (Cont.)

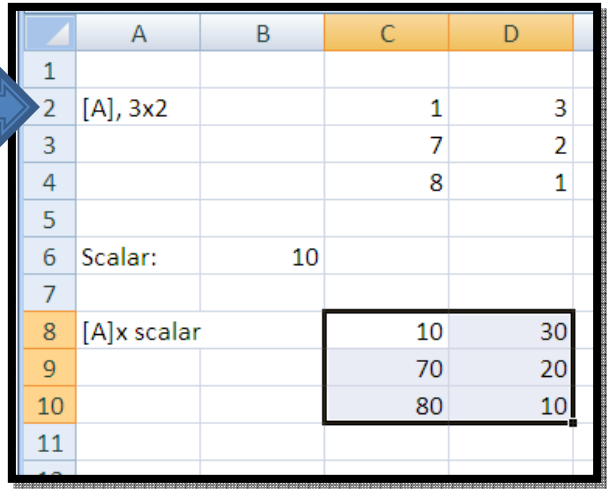


Select cell range

Enter Formula



Important!
Press [Crtl-Shift-Enter] after entering formula



Matrix Multiplication

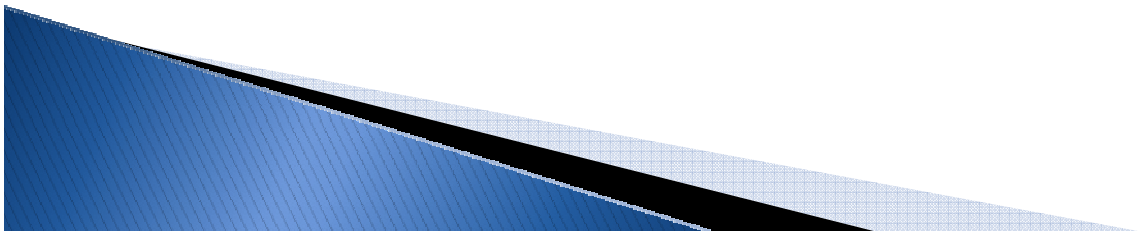
In order to multiply two matrices, the number of columns in the first matrix must equal the number of rows in the second matrix.

- Ex:

[A], 3x2

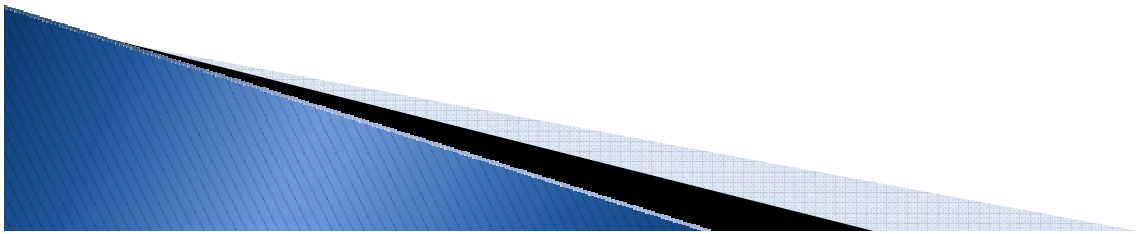
[e], 2x1

To multiply these matrices, “inside” dimensions must match (2,2). The product matrix dimension will have “outside” dimensions (3x1).

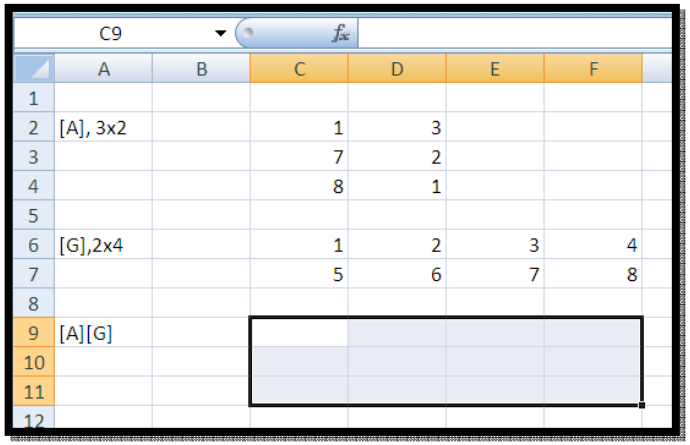


Matrix Multiplication (Cont.)

- Procedure:
  - Enter and name the arrays that will be multiplied.
  - Indicate the size of the result matrix by selecting the desired cell range.
  - Enter the following function:
    - MMULT(first matrix, second matrix) + [Ctrl-Shift-Enter]
- Note: Alternatively you can use the mouse to indicate the cell ranges instead of using arrays names.

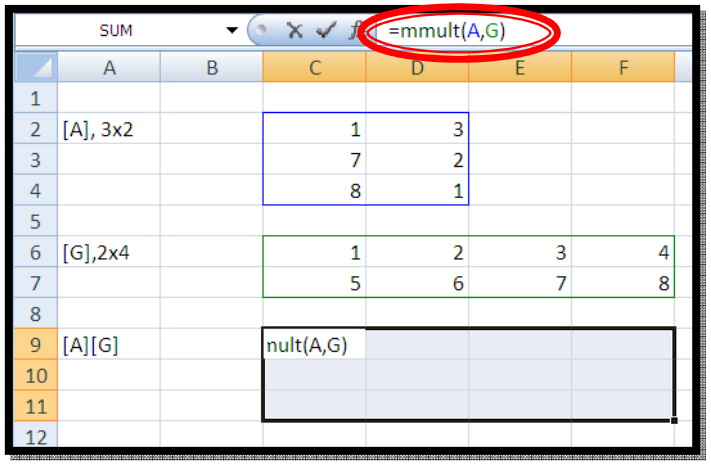


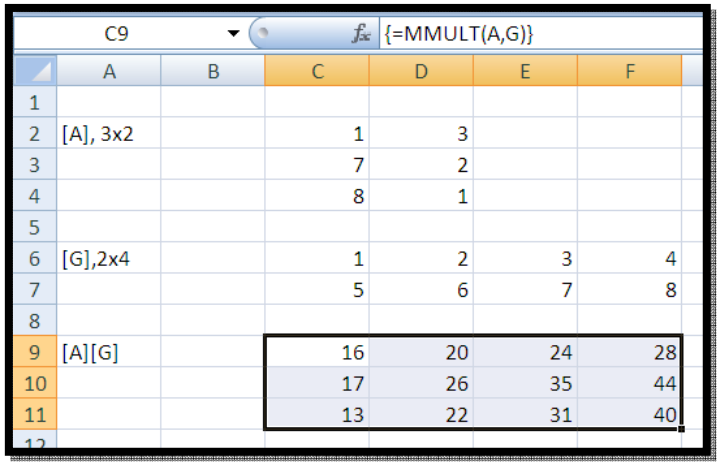
Matrix Multiplication (Cont.)



Select cell range
(outside dimensions)

Enter MMULT Function



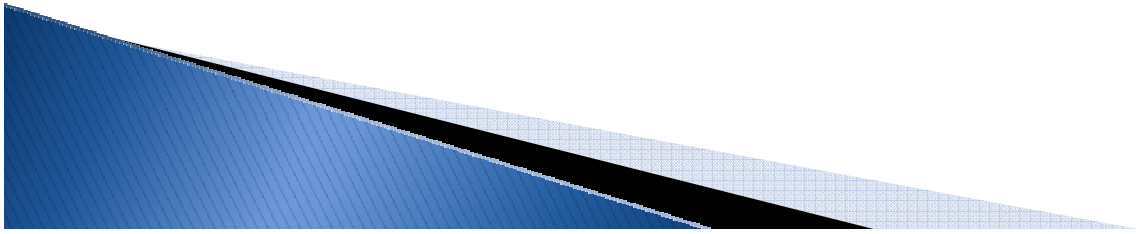


Important!
Press [Crtl-Shift-Enter]
after entering formula

Matrix Transpose

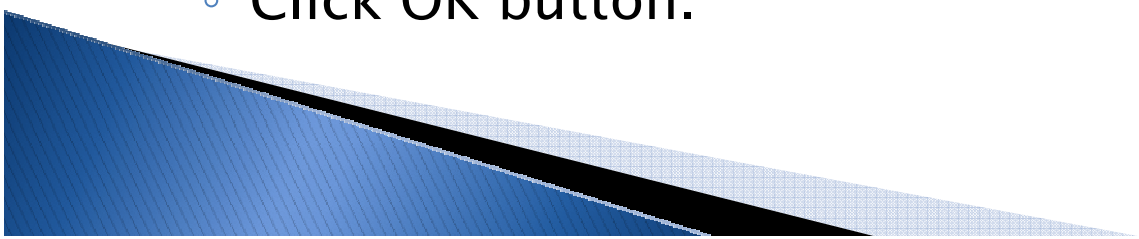
Any matrix can be transposed. To transpose a matrix, interchange the rows and columns.

- Excel features two methods to transpose a matrix:
  - By using **PASTE SPECIAL** *(does not automatically recalculates)*
  - By using the **TRANSPOSE()** array function *(automatically recalculates)*

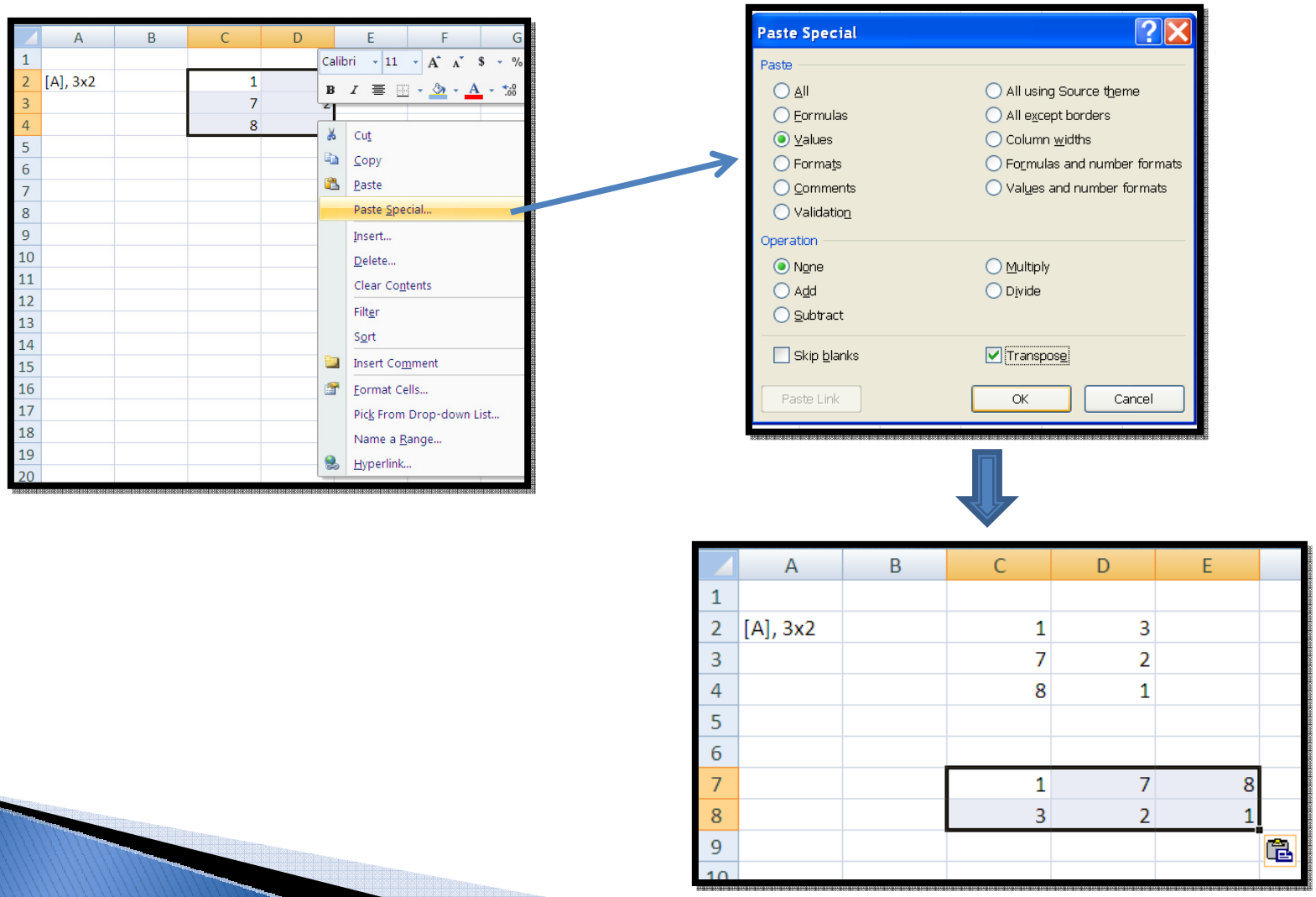


Matrix Transpose (Cont.)

- Using PASTE SPECIAL:
  - Select and copy the array to be transposed.
  - Indicate the cell that will contain the top-left corner of the result matrix.
  - Open the PASTE SPECIAL dialog, using right click or ribbon options **Home/Paste(menu)/Paste Special**.
  - Select values in the paste selection, and check the transpose check near the bottom of the dialog.
  - Click OK button.

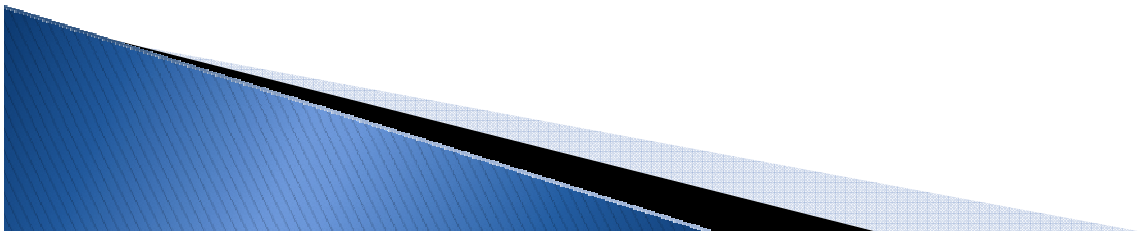


Matrix Transpose (Cont.)

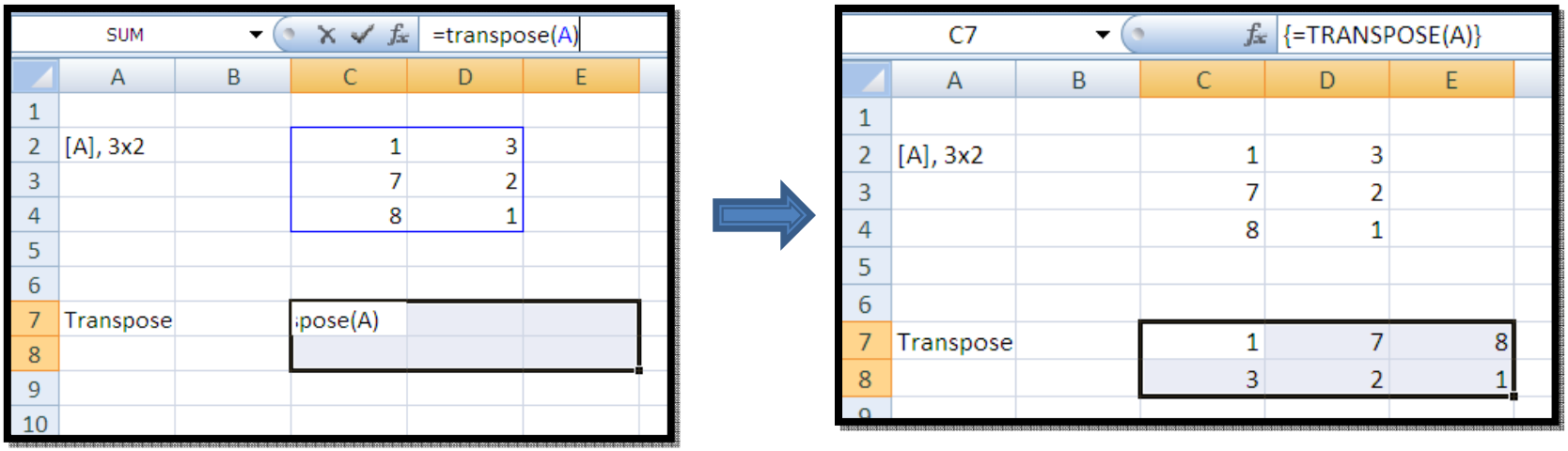


Matrix Transpose (Cont.)

- Using TRANSPOSE array function:
  - Enter the original matrix.
  - Indicate where the result should be placed, showing the exact size of the transposed matrix.
  - Enter the TRANSPOSE() array function + [Ctrl-Shift-Enter].



Matrix Transpose (Cont.)

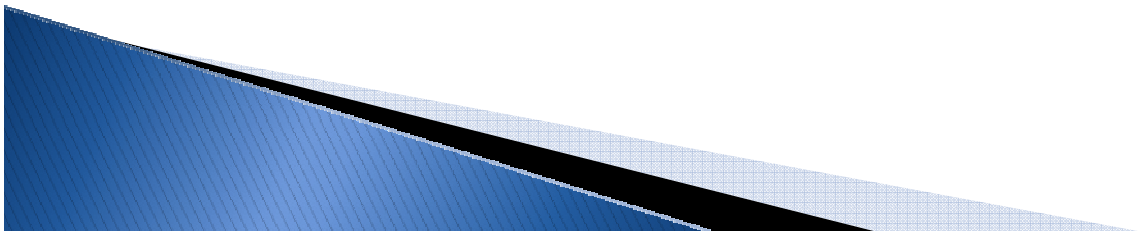


Inverting a Matrix

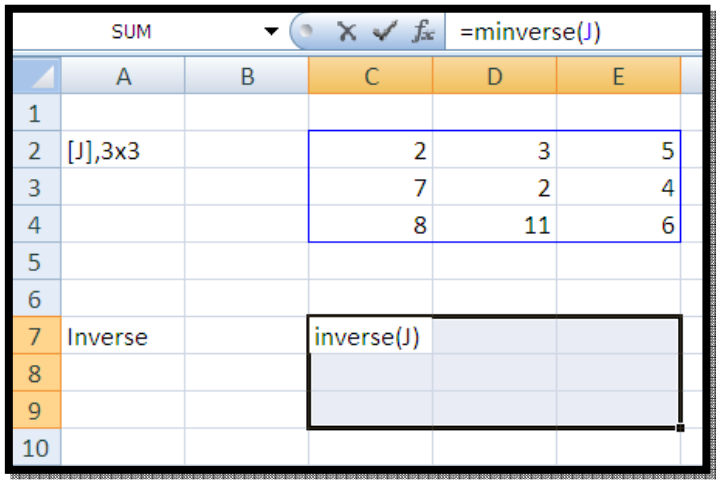
Only square, non singular matrices can be inverted.

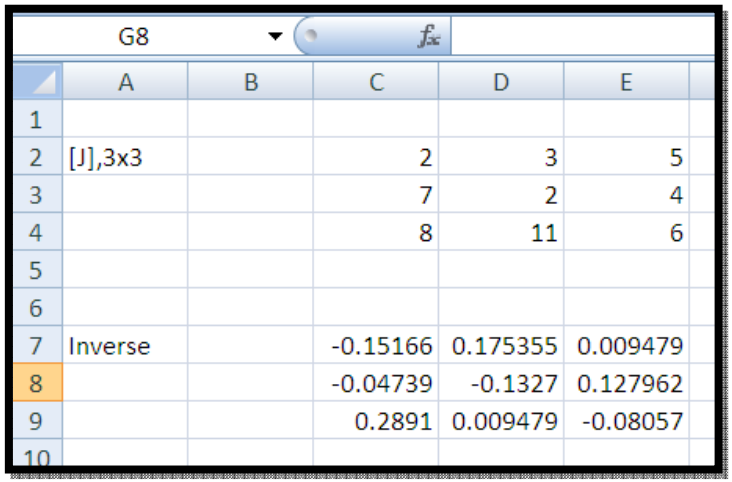
Procedure:

- Enter the matrix to be inverted and name it if desired.
- Indicate where the result should be placed, showing the exact size (same as original matrix).
- Enter the MINVERSE() array function + [Ctrl-Shift-Enter].



Inverting a Matrix (Cont.)



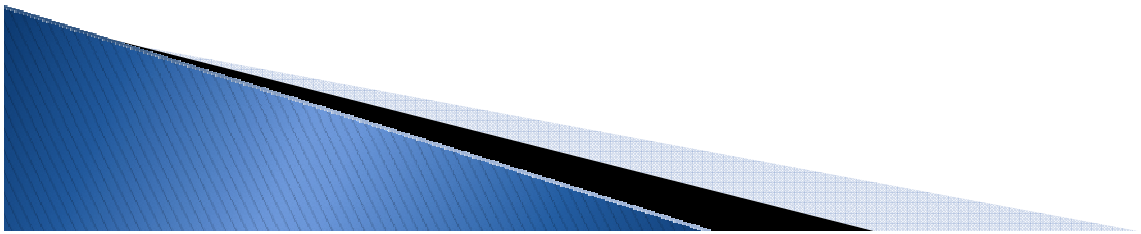


Matrix Determinant

The determinant of a matrix is a single value . If determinant=0, matrix is singular and can not be inverted.

A matrix is singular if:

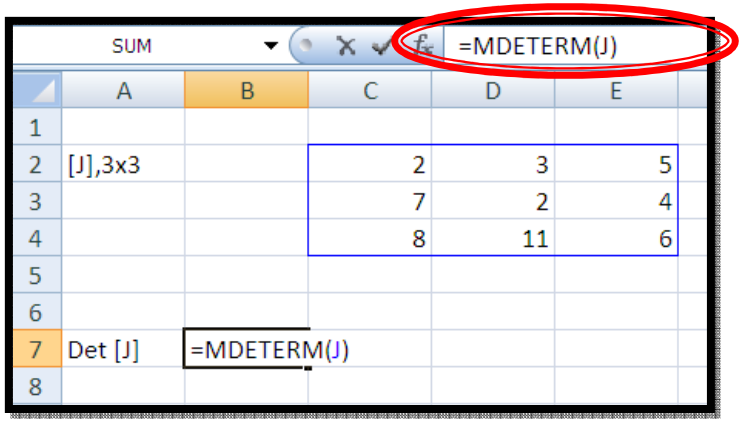
- Any row or column contains all zeros
- Any two rows or columns are identical
- Any row or column is a linear combinations of other rows or columns.

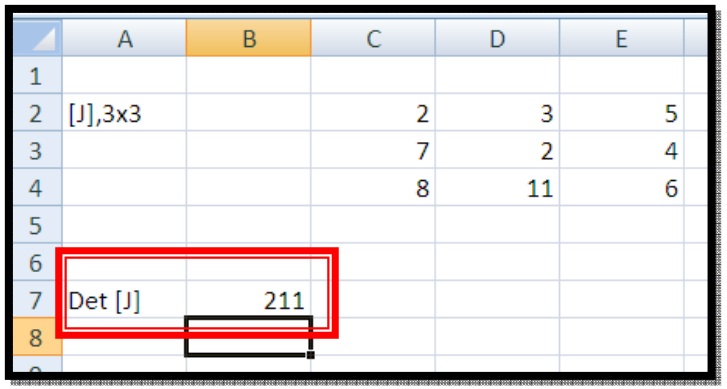


Matrix Determinant (Cont.)

To calculate the determinant of a matrix:

MDETERM() function





Solving Systems of Linear Equations

The process of solving simultaneous equations by using matrices works as follows:

1. Write equations in matrix form

$$\begin{aligned} 3x_1 + 2x_2 + 4x_3 &= 5 \\ 2x_1 + 5x_2 + 3x_3 &= 17 \\ 7x_1 + 2x_2 + 2x_3 &= 11 \end{aligned} \quad \Longrightarrow \quad [C][x] = [r]$$

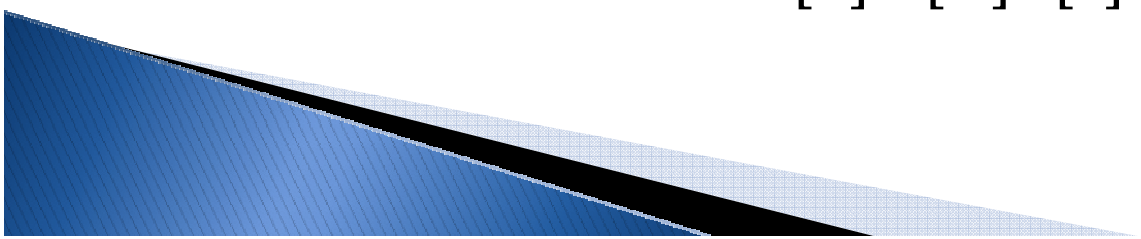
Where,

$$[C] = \begin{bmatrix} 3 & 2 & 4 \\ 2 & 5 & 3 \\ 7 & 2 & 2 \end{bmatrix} \qquad [x] = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} \qquad [r] = \begin{bmatrix} 5 \\ 17 \\ 11 \end{bmatrix}$$

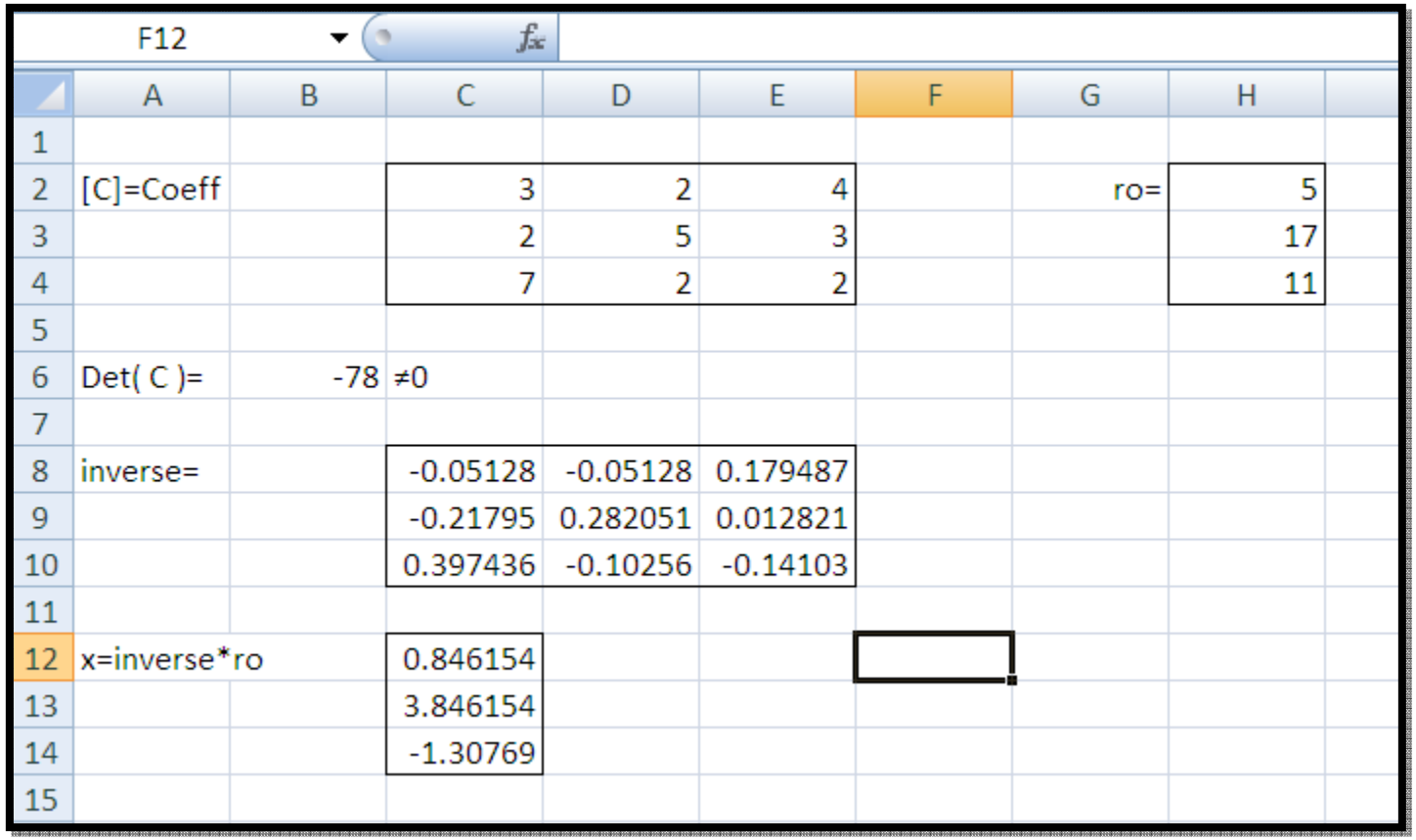
Solving Systems of Linear Equations (Cont.)

2. Calculate the determinant of [C]
   - If Det (C)=0, Solution undetermined
   - If Det (C)≠0, Solution can be determined
3. Invert the coefficient matrix [c]
4. The solution to the system of equations is given by:

$$[x] = [C]^{-1}[r]$$



Solving Systems of Linear Equations (Cont.)



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	A	B	C	D	E	F	G	H
1								
2	[C]=Coeff		3	2	4		ro=	5
3			2	5	3			17
4			7	2	2			11
5								
6	Det(C)=	-78	≠0					
7								
8	inverse=		-0.05128	-0.05128	0.179487			
9			-0.21795	0.282051	0.012821			
10			0.397436	-0.10256	-0.14103			
11								
12	x=inverse*ro		0.846154					
13			3.846154					
14			-1.30769					
15								