

# Math 107 Lecture 4

Built-in MATLAB Functions, Element-by-element Operations, and Logical Indexing

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## » Announcements and Objectives

### Announcements

- \* Skill Check 1 on Wednesday (60 mins then lecture)
- \* Pre-Notes due before start of next lecture
- \* Assignments Due Friday (9/13):
  - \* HW2 Handwritten Questions
  - \* HW2 Coding Problems
  - \* HW2 MATLAB File Upload
- \* Office Hours Update: All of my office hours are now offered in hybrid format.

### Objectives

- \* Solve equations involving linear combinations of vectors
- \* Practice using built-in MATLAB functions
- \* Change pixel values using logical indexing



## » Warm-ups

1. Use the `ones()` command to create a  $2 \times 4$  matrix A where every element is the number 9.
2. Use the `zeros()` command to create a  $2 \times 2$  matrix B where every element is the number 0.
3. Use the matrices A and B and matrix concatenation to create the matrix C shown below:

$$C = \begin{bmatrix} 0 & 0 & 9 & 9 & 9 & 9 \\ 0 & 0 & 9 & 9 & 9 & 9 \\ 9 & 9 & 9 & 9 & 0 & 0 \\ 9 & 9 & 9 & 9 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

## Built-in Functions

## » Built-in MATLAB functions

### MATLAB Reference:

[https://www.mathworks.com/help/matlab/referencelist.html?type=function&category=index&s\\_tid=CRUX\\_lftnav\\_function\\_index](https://www.mathworks.com/help/matlab/referencelist.html?type=function&category=index&s_tid=CRUX_lftnav_function_index)

Math	MATLAB Syntax
$\sqrt{14}$	<code>sqrt(14)</code>
$\sin(3\pi/4)$	<code>sin(3*pi/4)</code>
$\cos(2\pi)$	<code>cos(2*pi)</code>
$e^{-1}$	<code>exp(-1)</code>
$\ln(4)$	<code>log(4)</code>

**Remark:** When applied to a matrix, the above functions act on each element of the matrix.

## Element-by-element operations

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**MATLAB Syntax:** To perform operations **on each element** of a vector or matrix, MATLAB uses a period before the operation.

**Example:**  $x.^2$ ,  $x.*y$ ,  $x./y$

**Important Note:** Element-by-element operations are NOT the same as “matrix multiplication” or “dot products.”

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**Important Note:** Element-by-element operations are NOT the same as “matrix multiplication” or “dot products.”

**Question:** In order to perform element-by-element multiplication of matrices A and B, what must be true about A and B?



## » Other Built-in Functions

Let  $A$  be an  $m \times n$  matrix.

### MATLAB Syntax:

- \* `min(A)` - Returns minimum of each column
- \* `max(A)` - Returns maximum of each column
- \* `mean(A)` - Returns the mean of each column

## » Linear indexing

**MATLAB Syntax:** For a matrix  $A$ , we've seen that we can access elements with the syntax:

$$A(\text{row}, \text{col})$$

But we can also access elements of  $A$  using the syntax:

$$A(\#)$$

The syntax above is called **linear indexing**.

You can think of the syntax  $A(:)$  as arranging all of the columns of  $A$  one on top of the other into a single column.

## » `find()`

### MATLAB Syntax:

- \* `d=find(condition)` - Returns linear indices of elements that satisfy the condition
- \* `[r,c]=find(condition)` - Returns the row index (stored in `r`) and column index (stored in `c`) of elements that satisfy the condition

## Linear Combinations as Equations

## » Linear Combinations as Equations

### Example

Matrix (or vector) equations represent several equations at once.

**Example:** Find  $a$  and  $b$  such that

$$a \begin{bmatrix} 1 \\ 2 \end{bmatrix} + b \begin{bmatrix} 3 \\ -1 \end{bmatrix} = \begin{bmatrix} 1 \\ 9 \end{bmatrix}$$

## » Linear Combinations as Equations

**Question:** Find  $a$  and  $b$  such that

$$a \begin{bmatrix} 4 \\ -2 \end{bmatrix} + b \begin{bmatrix} 6 \\ 5 \end{bmatrix} = \begin{bmatrix} 4 \\ 14 \end{bmatrix}$$