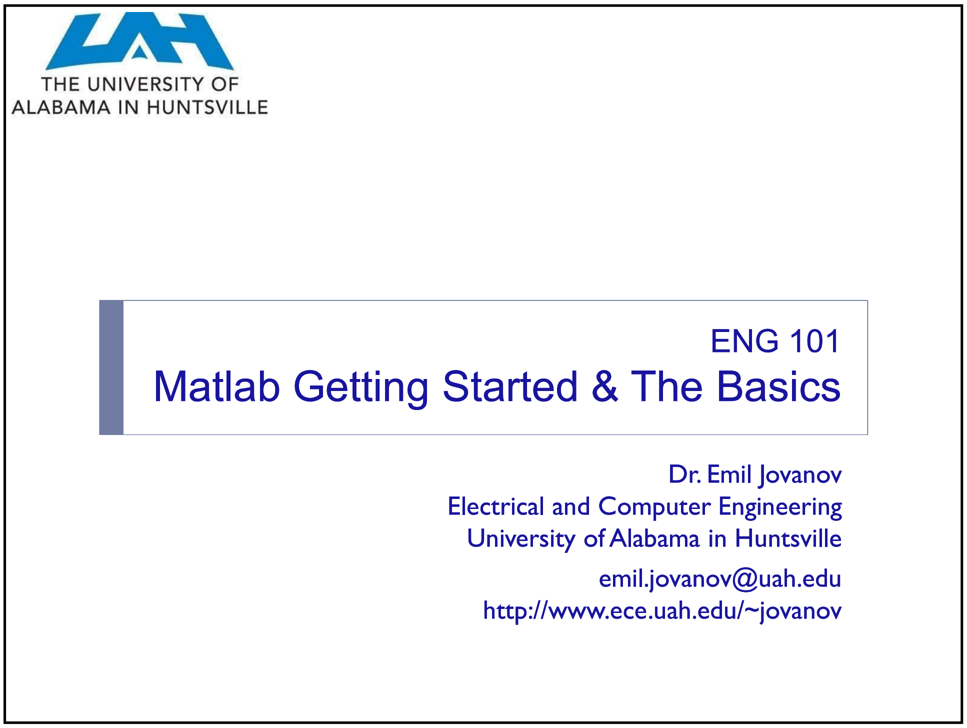

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ENG 101

Matlab Getting Started & The Basics

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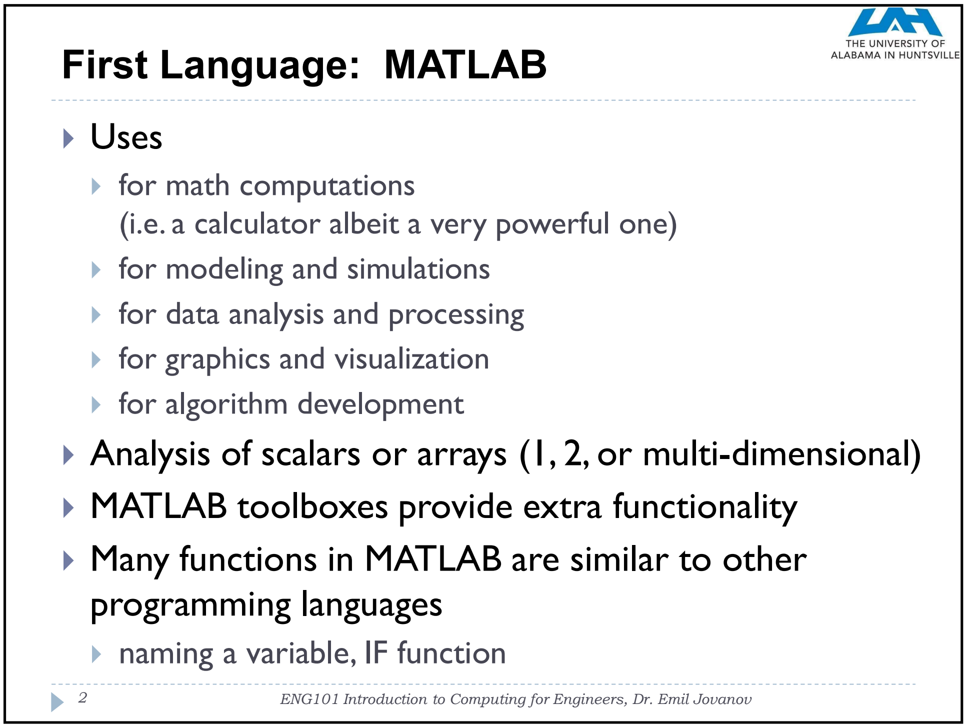

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First Language: MATLAB

- Uses
  - for math computations
    (i.e. a calculator albeit a very powerful one)
  - for modeling and simulations
  - for data analysis and processing
  - for graphics and visualization
  - for algorithm development
- Analysis of scalars or arrays (1, 2, or multi-dimensional)
- MATLAB toolboxes provide extra functionality
- Many functions in MATLAB are similar to other programming languages
  - naming a variable, IF function

Where to Get MATLAB

- Student License
  - A free student license for MATLAB is available for both Windows and Mac machines
  - Go to my.uah.edu; under OIT Services click on *Chargerware*
  - A MATLAB icon should appear on the main page;
    if not click on *Analysis and Modeling* on the left menu list and
    then choose *MATLAB*
  - Follow the instructions; go to the OIT Helpdesk if you have any issues
  - Some older versions of MATLAB may be fine to use; check with me to be sure

Getting Started in MATLAB

- There are several MATLAB windows for which you must become familiar. Let’s open MATLAB and take a look at them.

○ Command Window

○ Figure Window

○ Editor Window

○ Help Window

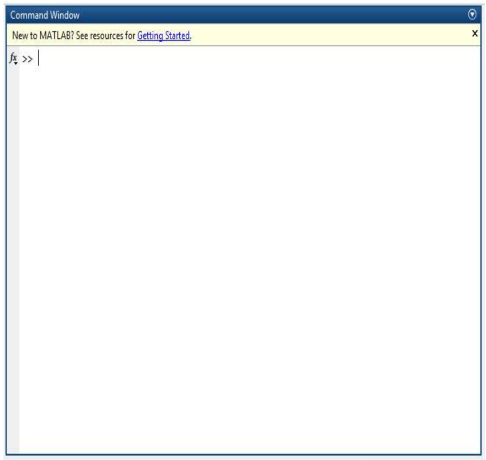
○ Command History Window

○ Workspace Window

○ Current Folder Window

Command Window

- Used for executing commands, running scripts, and opening other windows.
- Command prompt: >>
- Getting started – using the command window as a calculator.
- 3 important items
  - Semicolon – ends a command
  - Percent – add a comment
  - clc – clears Command Window



New to MATLAB? See resources for Getting Started.

```
fx >> |
```

Go To MATLAB

MATLAB as a Calculator

Operation	Symbol
Addition	+
Subtraction	-
Multiplication	*
Division	/
Exponentiation†	^

- Order of Operations
- 1st Parentheses (innermost first)
- 2nd Exponentiation
- 3rd Multiplication/Division (equal)
- 4th Addition/Subtraction (equal)

- Higher order operations are executed first. For equal order operations, the expression is executed from left to right. Parentheses are used to change the order of calculations.

† Exponentiation is used to raise variables/numbers to a power and is not the same as the exponential function.

Matlab desktop

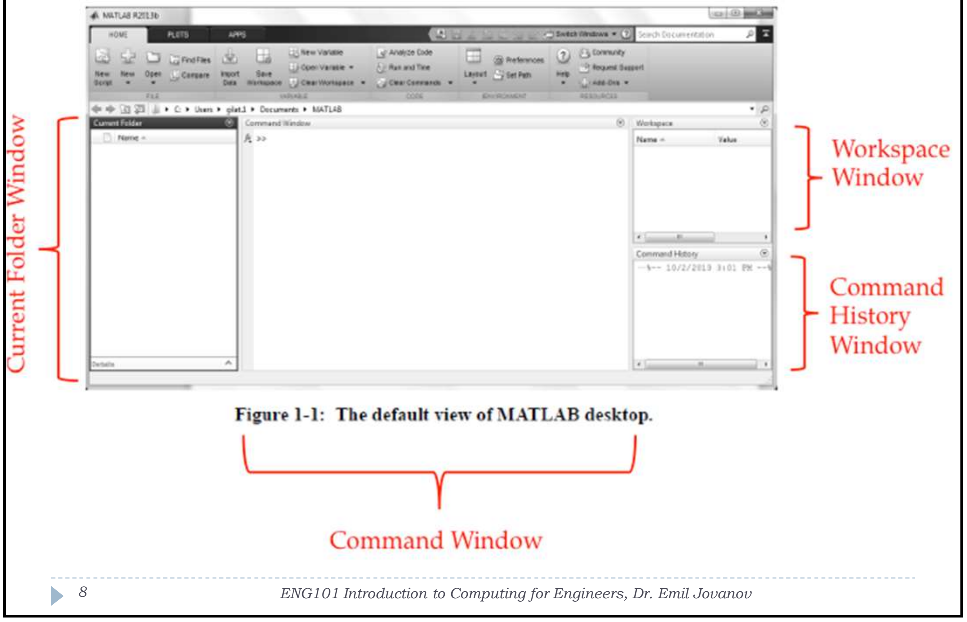
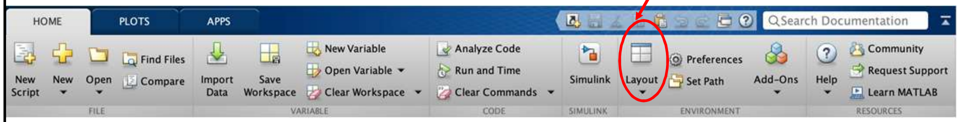


Figure 1-1: The default view of MATLAB desktop.

Command History

Often easier to just show Command History Window. To close all other windows:

- Click on down-arrow button in top right of windows, select Close
  or
- From tool strip, select Layout, then Command Window Only



Matlab windows

Window	Purpose
Command Window	Main window, enters variables, runs programs.
Figure Window	Contains output from graphic commands.
Editor Window	Creates and debugs script and function files.
Help Window	Provides help information.
Command History Window	Logs commands entered in the Command Window.
Workspace Window	Provides information about the variables that are stored.
Current Folder Window	Shows the files in the current folder.

Matlab windows: Plot

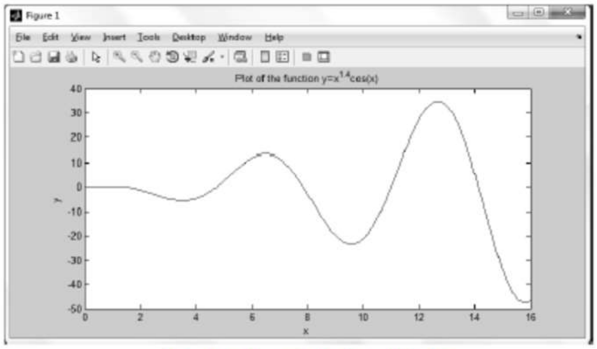
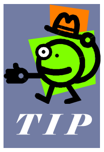


Figure 1
File Edit View Insert Tools Desktop Window Help
Plot of the function y=x^1.4*cos(x)
40
30
20
10
0
-10
-20
-30
-40
-50
0
2
4
6
8
10
12
14
16
x
y

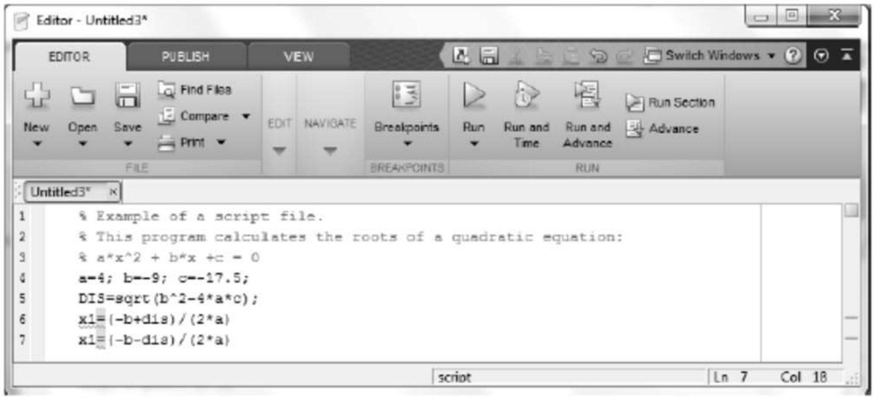
Figure 1-2: Example of a Figure Window.

Figure Window opens automatically after any command that draws a graph



If you don't see a figure window open up, look on the task bar for a black, program bar and click it

Matlab windows: Editor



```
% Example of a script file.
% This program calculates the roots of a quadratic equation:
% a*x^2 + b*x +c = 0
a=4; b=-9; c=-17.5;
DIS=sqrt(b^2-4*a*c);
x1=(-b+dis)/(2*a)
x1=(-b-dis)/(2*a)
```

Figure 1-3: Example of an Editor Window.

Use Editor Window to write and debug MATLAB scripts. Open with `edit` command

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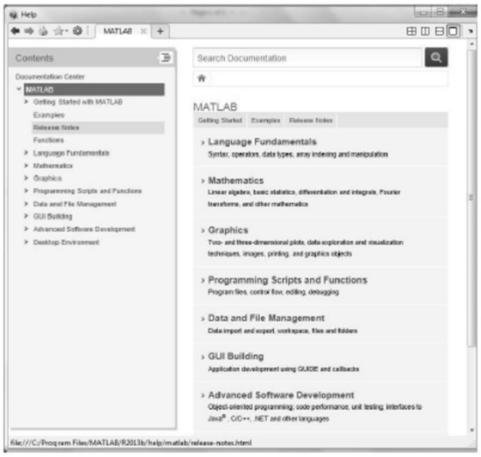
Matlab windows: Help


Help
MATLAB
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Mathematics
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Programming Scripts and Functions
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Advanced Software Development
Desktop Environment
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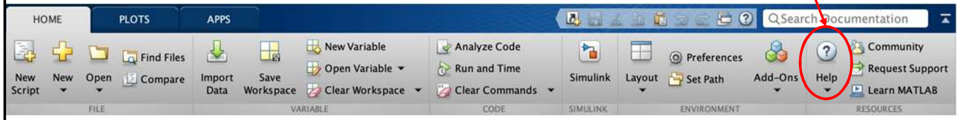
Examples
Release Notes
Language Fundamentals
Syntax, operators, data types, array indexing and manipulation
Mathematics
Linear algebra, basic statistics, differentiation and integrals, Fourier transforms, and other mathematics
Graphics
Two- and three-dimensional plots, data exploration and visualization techniques, images, printing, and graphics objects
Programming Scripts and Functions
Program files, control flow, editing, debugging
Data and File Management
Data import and export, workspace, files and folders
GUI Building
Application development using GUIDE and callbacks
Advanced Software Development
Object-oriented programming, code performance, unit testing, interfaces to Java®, C/C++, .NET and other languages
file:///C:/Program Files/MATLAB/R2013b/help/matlab/release-notes.html

Get Help Window by clicking on Help icon (question mark) in tool strip



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More Fun with Windows

- To reopen a window, click the Layout icon and then click on the window name
- To get the default window layout (shown before) click the Layout icon, then click Default
- Undocking a window means removing it from the main MATLAB window and then being able to move it independently. To undock a window:
  - Drag the window’s title bar until the cursor is outside the MATLAB window, then release the cursor
    or
  - Click on the Window Action icon, then click on Undock

More Fun with Windows

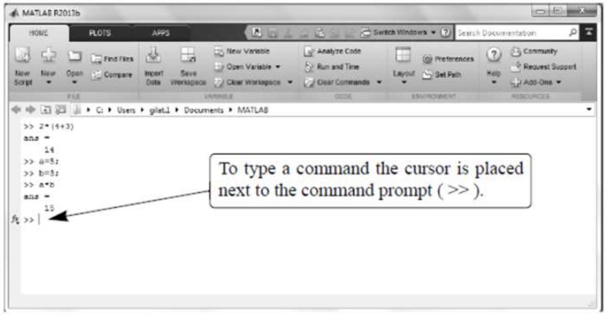
- Undocking a window means removing it from the main MATLAB window and then being able to move it independently. To undock a window:
  - Drag the window's title bar until
    the cursor is outside the MATLAB window,
    then release the cursor
    or
  - Click on the Window Action icon, then click on Undock
- To dock a window:
  - Click on the Window Action icon, then click on Dock

Command Window is MATLAB's main window. Use it to:

- Execute commands
- Open other windows
- Run programs that you've written
- Manage the MATLAB software

Basic procedure

1. At prompt (>>), type in MATLAB command
2. Press ENTER key
3. MATLAB displays result in Command Window, followed by a prompt
4. Repeat from step 1



```
>> 2*(4+3)
ans =
    14
>> a=5;
>> b=3;
>> a*b
ans =
    15
>> |
```

To type a command the cursor is placed next to the command prompt (>>).

Figure 1.5: The Command Window.

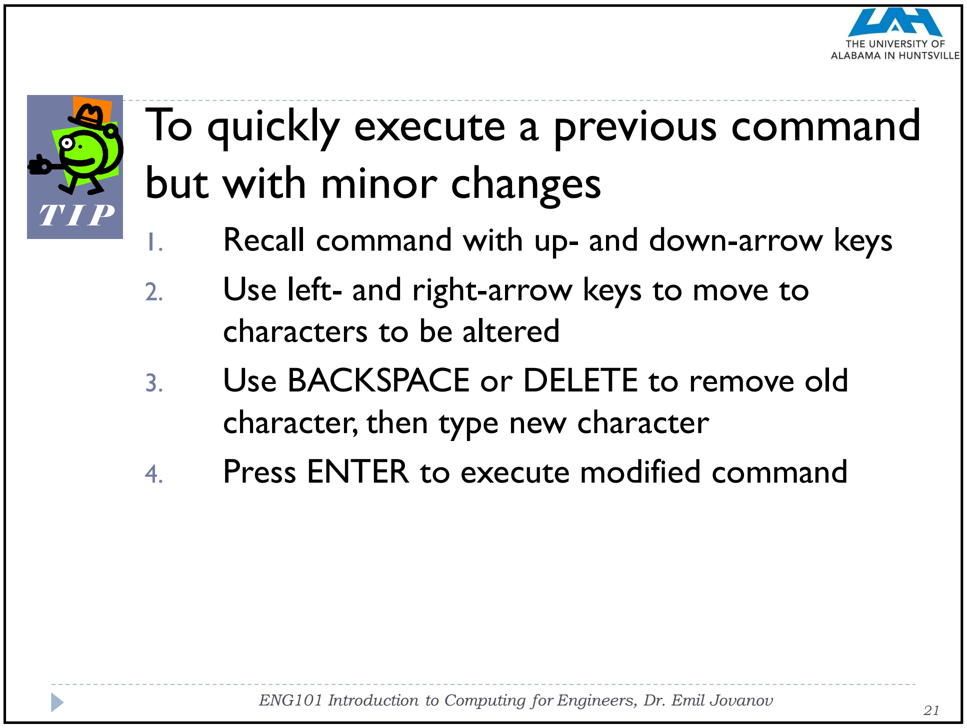
Notes on Command Window

- To start a command, make sure cursor is next to prompt
- MATLAB won't respond until you press ENTER
  - It then executes only last command
  - Commands before last one may still be visible, but MATLAB doesn't execute them
- Can type several commands in same line by putting a comma between commands
  - Hard to read, so don't do this often
- If command too long to fit on line, can continue to next line by typing ellipsis (3 periods, i.e., …)
  and then pressing ENTER

When cursor is in bottom command line:

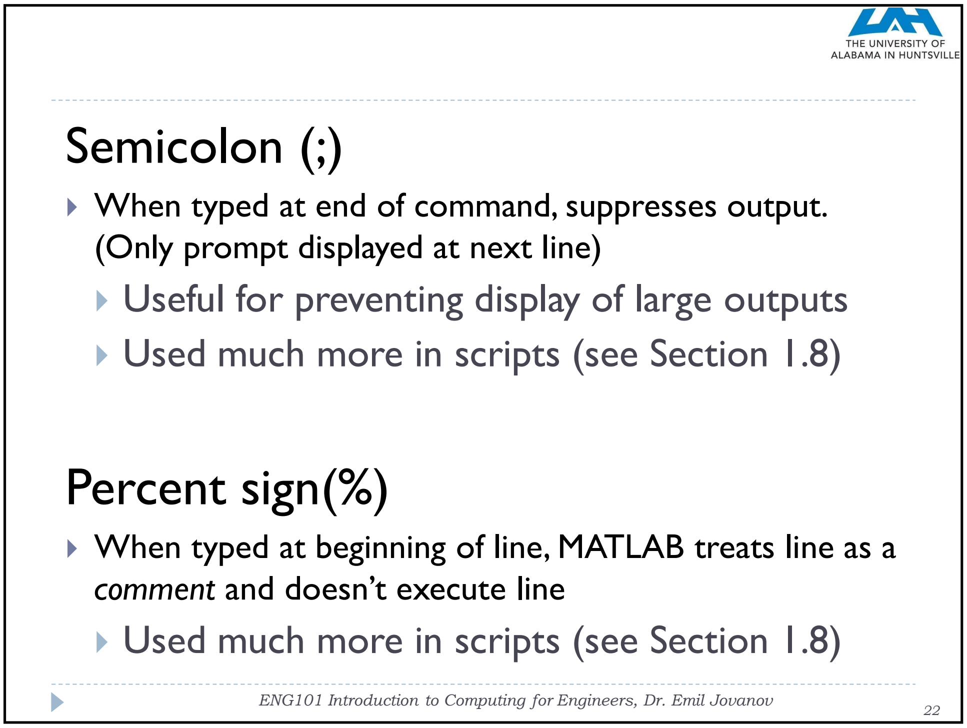
- ← key moves cursor one character to left
- → key moves cursor one character to right
- ↑ key recalls preceding command
- ↓ key recalls command that follows one being displayed, i.e., undoes ↑

- PAGE-UP key moves up to previous commands in a window-size at a time
- PAGE-DOWN key moves down to previous commands in a window-size at a time
- BACKSPACE key deletes character to left of cursor
- DELETE key deletes character to right of cursor



To quickly execute a previous command but with minor changes

1. Recall command with up- and down-arrow keys
2. Use left- and right-arrow keys to move to characters to be altered
3. Use BACKSPACE or DELETE to remove old character, then type new character
4. Press ENTER to execute modified command

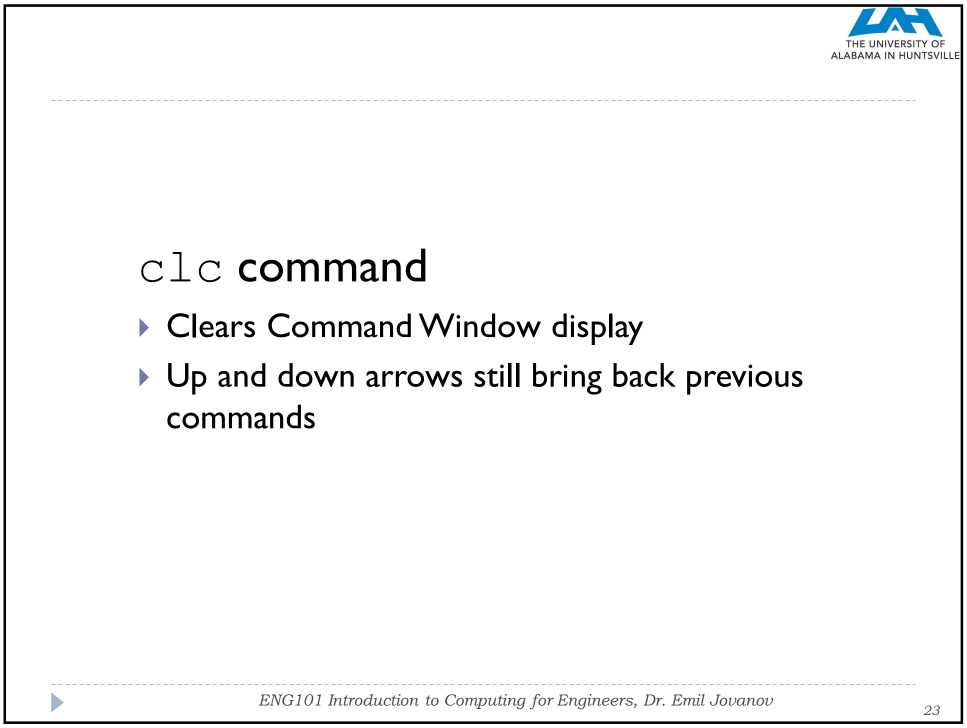


Semicolon (;)

- When typed at end of command, suppresses output. (Only prompt displayed at next line)
  - Useful for preventing display of large outputs
  - Used much more in scripts (see Section 1.8)

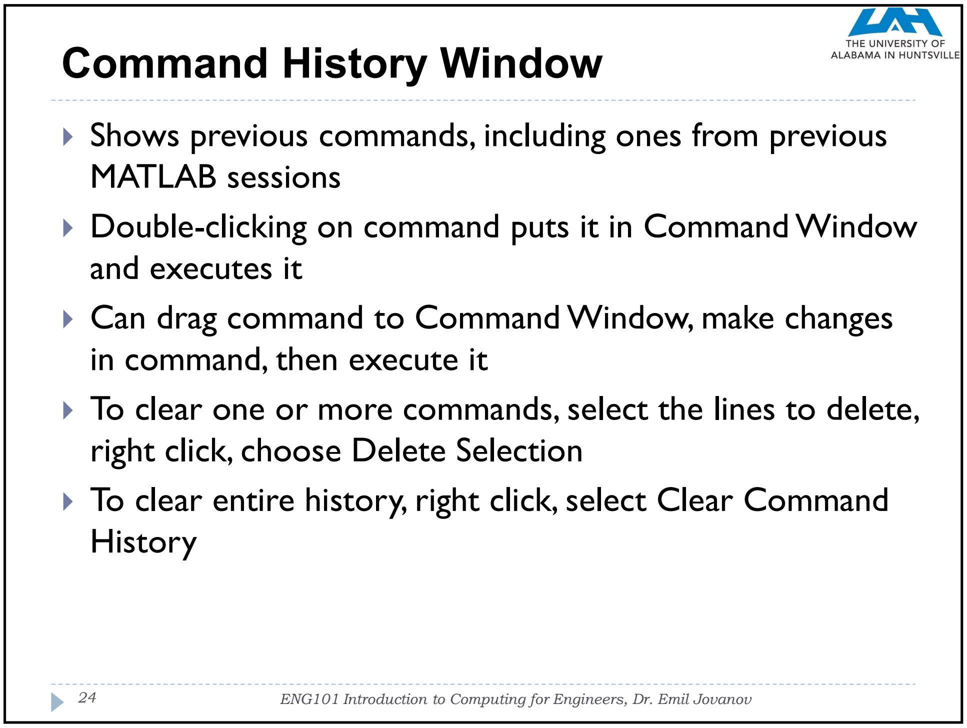
Percent sign(%)

- When typed at beginning of line, MATLAB treats line as a *comment* and doesn't execute line
  - Used much more in scripts (see Section 1.8)



`clc` command

- Clears Command Window display
- Up and down arrows still bring back previous commands



Command History Window

- Shows previous commands, including ones from previous MATLAB sessions
- Double-clicking on command puts it in Command Window and executes it
- Can drag command to Command Window, make changes in command, then execute it
- To clear one or more commands, select the lines to delete, right click, choose Delete Selection
- To clear entire history, right click, select Clear Command History

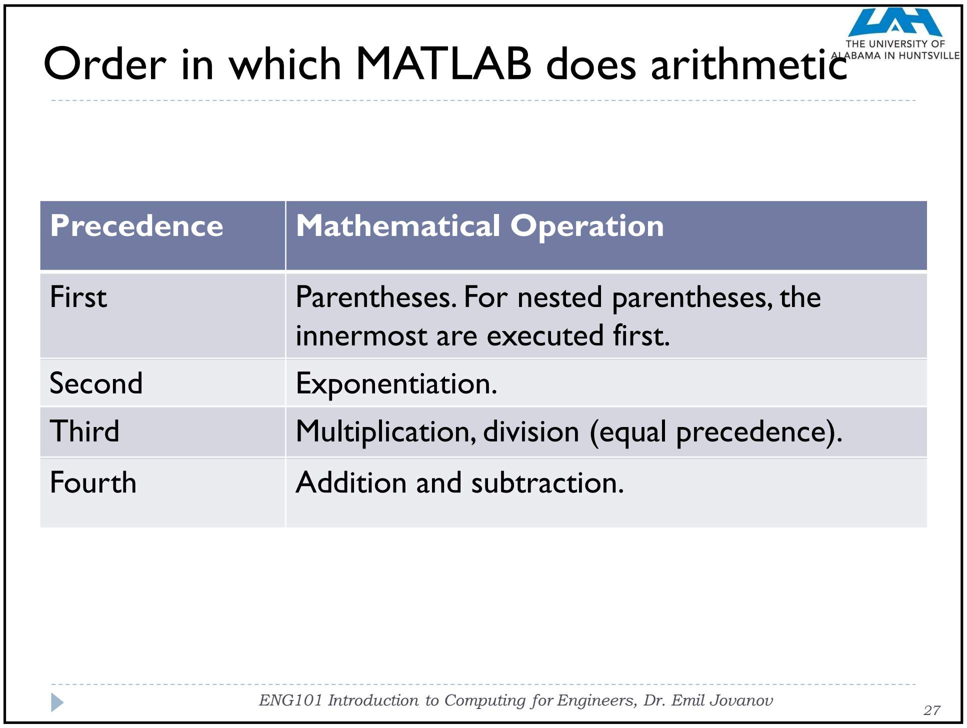
In this chapter will only discuss arithmetic with *scalars* (single numbers)

- Can do arithmetic directly on numbers (like a calculator)
- Can store numbers in variables

Symbols for arithmetic are:

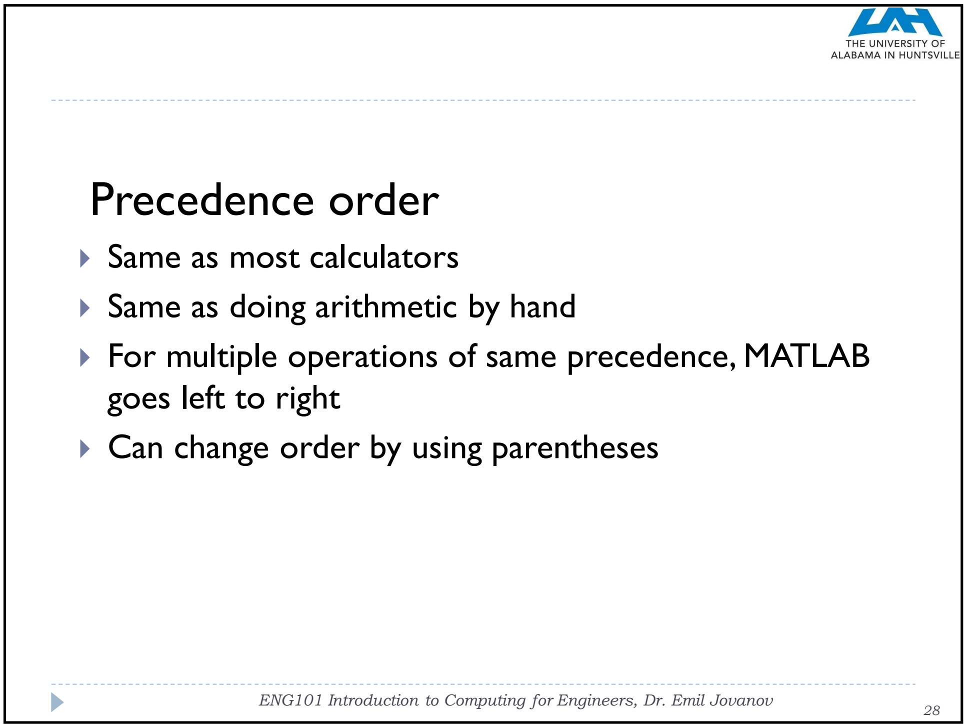
Operation	Symbol	Example
Addition	+	5 + 3
Subtraction	–	5 – 3
Multiplication	*	5 * 3
Right division	/	5 / 3
Left division	\	5 \ 3 = 3 / 5
Exponentiation	^	5 ^ 3 (means 5^3 = 125)

Left division rarely used with scalars



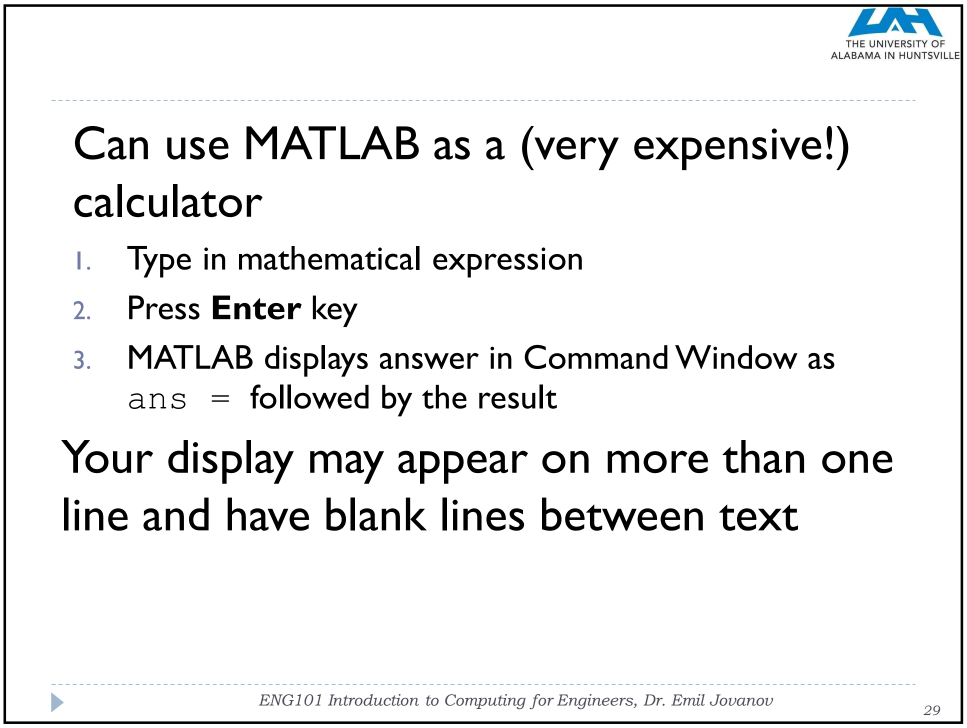
Order in which MATLAB does arithmetic

Precedence	Mathematical Operation
First	Parentheses. For nested parentheses, the innermost are executed first.
Second	Exponentiation.
Third	Multiplication, division (equal precedence).
Fourth	Addition and subtraction.



Precedence order

- Same as most calculators
- Same as doing arithmetic by hand
- For multiple operations of same precedence, MATLAB goes left to right
- Can change order by using parentheses



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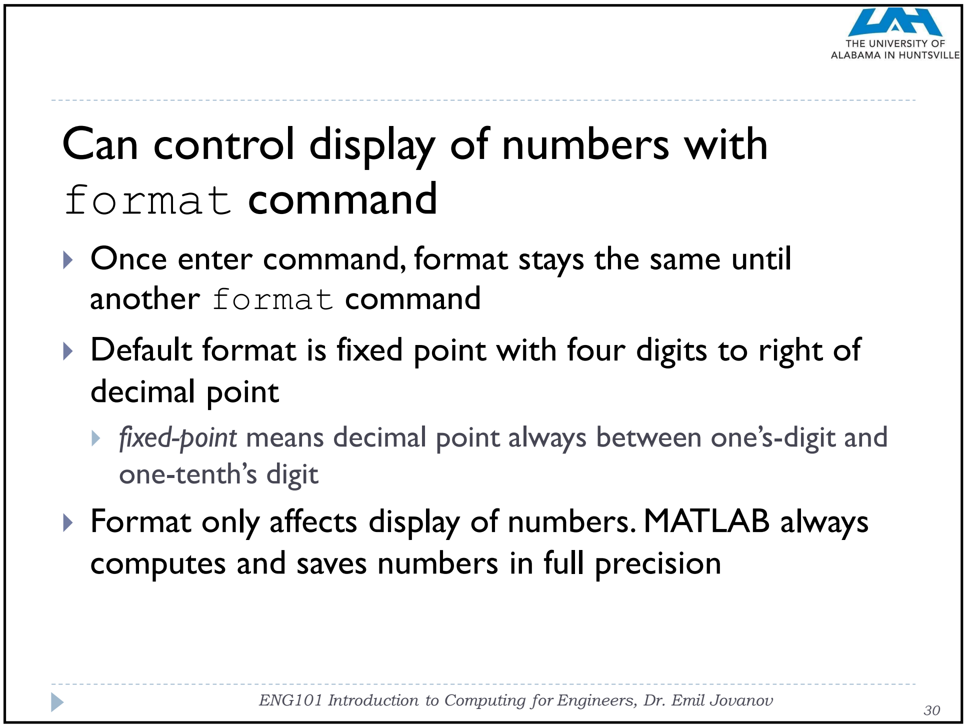
Can use MATLAB as a (very expensive!) calculator

1. Type in mathematical expression
2. Press **Enter** key
3. MATLAB displays answer in Command Window as `ans =` followed by the result

Your display may appear on more than one line and have blank lines between text



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Can control display of numbers with `format` command

- Once enter command, format stays the same until another `format` command
- Default format is fixed point with four digits to right of decimal point
  - *fixed-point* means decimal point always between one's-digit and one-tenth's digit
- Format only affects display of numbers. MATLAB always computes and saves numbers in full precision

Some types of formatting

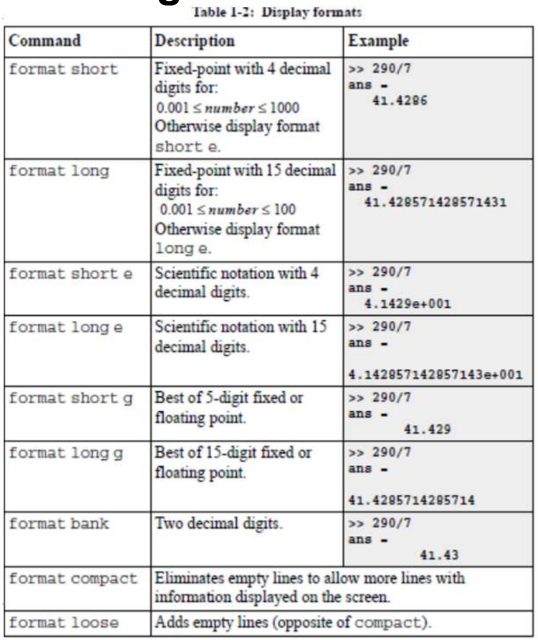


Table 1-2: Display formats

Command	Description	Example

`format short`	Fixed-point with 4 decimal digits for:
	$0.001 \le number \le 1000$
	Otherwise display format `short e`.
		`>> 290/7`
		`ans =`
		`41.4286`

`format long`	Fixed-point with 15 decimal digits for:
	$0.001 \le number \le 100$
	Otherwise display format `long e`.
		`>> 290/7`
		`ans =`
		`41.428571428571431`

`format short e`	Scientific notation with 4 decimal digits.	`>> 290/7`
		`ans =`
		`4.1429e+001`

`format long e`	Scientific notation with 15 decimal digits.	`>> 290/7`
		`ans =`
		`4.142857142857143e+001`

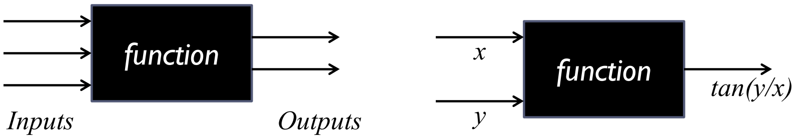
`format short g`	Best of 5-digit fixed or floating point.	`>> 290/7`
		`ans =`
		`41.429`

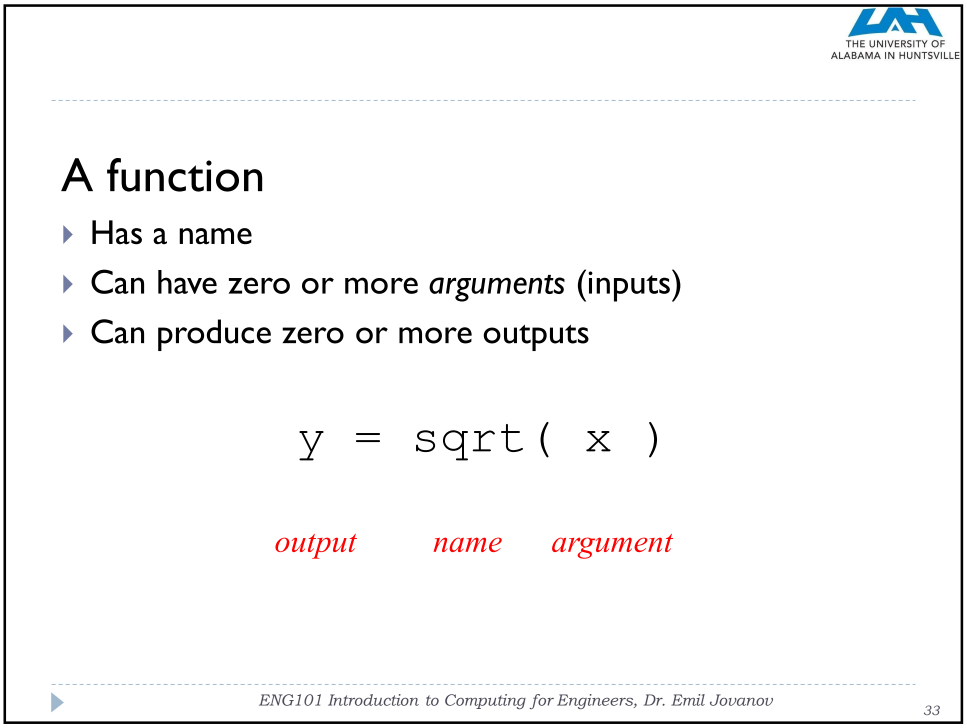
`format long g`	Best of 15-digit fixed or floating point.	`>> 290/7`
		`ans =`
		`41.4285714285714`

`format bank`	Two decimal digits.	`>> 290/7`
		`ans =`
		`41.43`

`format compact`	Eliminates empty lines to allow more lines with information displayed on the screen.	
`format loose`	Adds empty lines (opposite of `compact`).	

MATLAB expressions can include functions. You can think of a *function* as a black box that, in general, takes inputs, does some computations with them, and produces outputs.



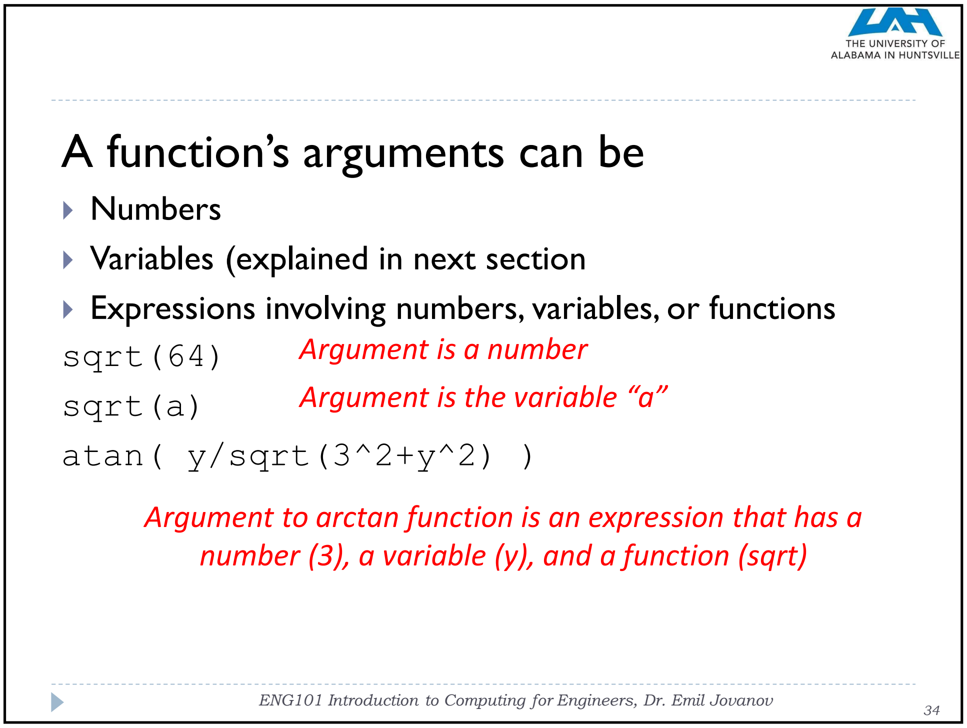


A function

- Has a name
- Can have zero or more *arguments* (inputs)
- Can produce zero or more outputs

```
y = sqrt( x )
```

output *name* *argument*



A function's arguments can be

- Numbers
- Variables (explained in next section
- Expressions involving numbers, variables, or functions

`sqrt(64)` *Argument is a number*

`sqrt(a)` *Argument is the variable "a"*

`atan( y/sqrt(3^2+y^2) )`

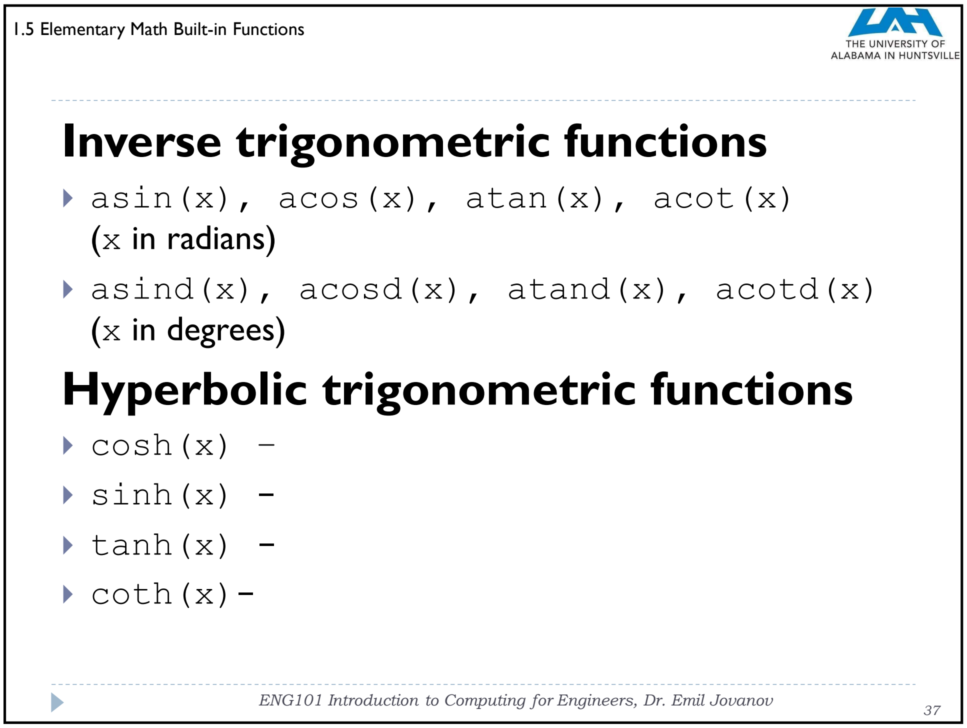
Argument to arctan function is an expression that has a number (3), a variable (y), and a function (sqrt)

Elementary math functions

- `sqrt(x)` – square root
- `nthroot(x,n)` – nth real root
- `exp(x)` – e^x
- `abs(x)` – absolute value
- `log(x)` – natural log (base e)
- `log10(x)` – log base 10
- `factorial(x)` – *x!*

Trigonometric functions

- `sin(x)` – sine (`x` in radians)
- `sind(x)` – sine (`x` in degrees)
- `cos(x)` – cosine (`x` in radians)
- `cosd(x)` – cosine (`x` in degrees)
- `tan(x)` – tangent (`x` in radians)
- `tand(x)` – tangent (`x` in degrees)
- `cot(x)` – cotangent (`x` in radians)
- `cotd(x)` - cotangent (`x` in degrees)



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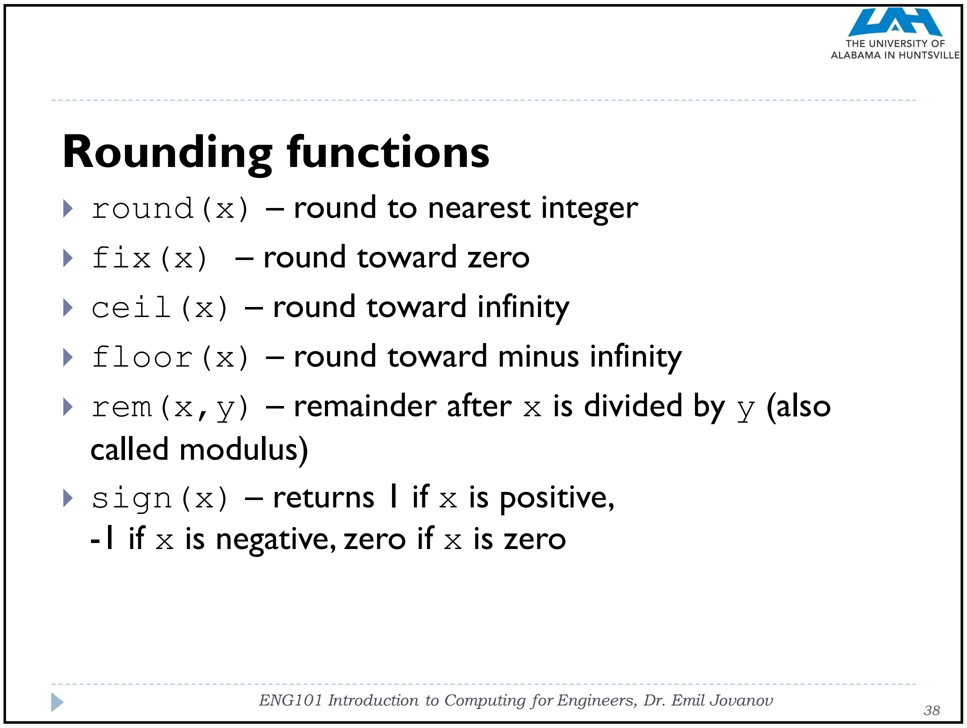
Inverse trigonometric functions

- `asin(x), acos(x), atan(x), acot(x)` (`x` in radians)
- `asind(x), acosd(x), atand(x), acotd(x)` (`x` in degrees)

Hyperbolic trigonometric functions

- `cosh(x)` –
- `sinh(x)` -
- `tanh(x)` -
- `coth(x)`-



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Rounding functions

- `round(x)` – round to nearest integer
- `fix(x)` – round toward zero
- `ceil(x)` – round toward infinity
- `floor(x)` – round toward minus infinity
- `rem(x,y)` – remainder after `x` is divided by `y` (also called modulus)
- `sign(x)` – returns 1 if `x` is positive, -1 if `x` is negative, zero if `x` is zero