

### Starting and Stopping

<code>octave</code> <span>[<code>--gui</code>]</span>	start Octave CLI/GUI session
<code>octave</code> <i>file</i>	run Octave commands in <i>file</i>
<code>octave</code> <code>--eval</code> <i>code</i>	evaluate <i>code</i> using Octave
<code>octave</code> <code>--help</code>	describe command line options
<code>quit</code> or <code>exit</code>	exit Octave
<code>Ctrl-C</code>	terminate current command and return to top-level prompt

### Getting Help

<code>help</code> <i>command</i>	briefly describe <i>command</i>
<code>doc</code>	use Info to browse Octave manual
<code>doc</code> <i>command</i>	search for <i>command</i> in Octave manual
<code>lookfor</code> <i>str</i>	search for <i>command</i> based on <i>str</i>

### Command Completion and History

<code>TAB</code>	complete a command or variable name
<code>Alt-?</code>	list possible completions
<code>Ctrl-r</code> <code>Ctrl-s</code>	search command history

### Directory and Path Commands

<code>cd</code> <i>dir</i>	change working directory to <i>dir</i>
<code>pwd</code>	print working directory
<code>ls</code> <span>[<i>options</i>]</span>	print directory listing
<code>what</code>	list .m/.mat files in the current directory
<code>path</code>	search path for Octave functions
<code>pathdef</code>	default search path
<code>addpath</code> ( <i>dir</i> )	add a directory to the path
<code>getenv</code> ( <i>var</i> )	value of environment variable

### Package Management

Add-on packages are independent of core Octave, listed at <https://packages.octave.org/>

<code>pkg</code> <code>install</code> <code>-forge</code> <i>pkg</i>	download and install <i>pkg</i>
<code>pkg</code> <code>install</code> <i>file.tar.gz</i>	install pre-downloaded package file
<code>pkg</code> <code>list</code>	show installed packages
<code>pkg</code> <code>load</code> / <code>pkg</code> <code>unload</code>	load/unload installed package
<code>statistics</code> <code>optimization</code>	various common packages
<code>control</code> <code>signal</code> <code>image</code>	
<code>symbolic</code> etc.	

### Matrices

Square brackets delimit literal matrices. Commas separate elements on the same row. Semicolons separate rows. Commas may be replaced by spaces, and semicolons may be replaced by newlines. Elements of a matrix may be arbitrary expressions, assuming all the dimensions agree.

<code>[</code> <i>x</i> , <i>y</i> , ... <code>]</code>	enter a row vector
<code>[</code> <i>x</i> ; <i>y</i> ; ... <code>]</code>	enter a column vector
<code>[</code> <i>w</i> , <i>x</i> ; <i>y</i> , <i>z</i> <code>]</code>	enter a 2×2 matrix
<code>rows</code> <code>columns</code>	number of rows/columns of matrix
<code>zeros</code> <code>ones</code>	create matrix of zeros/ones
<code>eye</code> <code>diag</code>	create identity/diagonal matrix
<code>rand</code> <code>randi</code> <code>randn</code>	create matrix of random values
<code>sparse</code> <code>spalloc</code>	create a sparse matrix
<code>all</code>	true if all elements nonzero

<code>any</code>	true if at least one element nonzero
<code>nnz</code>	number of nonzero elements

### Multi-dimensional Arrays

<code>ndims</code>	number of dimensions
<code>reshape</code> <code>squeeze</code>	change array shape
<code>resize</code>	change array shape, lossy
<code>cat</code>	join arrays along a given dimension
<code>permute</code> <code>ipermute</code>	like N-dimensional transpose
<code>shiftdim</code>	
<code>circshift</code>	cyclically shift array elements
<code>meshgrid</code>	matrices useful for vectorization

### Ranges

Create sequences of real numbers as row vectors.

<i>base</i> <code>:</code> <i>limit</i>	
<i>base</i> <code>:</code> <i>incr</i> <code>:</code> <i>limit</i>	
<i>incr</i> <code>==</code> 1 if not specified. Negative ranges allowed.	

### Numeric Types and Values

Integers saturate in Octave. They do not roll over.

<code>int8</code> <code>int16</code> <code>int32</code> <code>int64</code>	signed integers
<code>uint8</code> <code>uint16</code> <code>uint32</code>	unsigned integers
<code>uint64</code>	
<code>single</code> <code>double</code>	32-bit/64-bit IEEE floating point
<code>intmin</code> <code>intmax</code> <code>flintmax</code>	integer limits of given type
<code>realmin</code> <code>realmax</code>	floating point limits of given type
<code>inf</code> <code>nan</code> <code>NA</code>	IEEE infinity, NaN, missing value
<code>eps</code>	machine precision
<code>pi</code> <code>e</code>	3.14159..., 2.71828...
<code>i</code> <code>j</code>	$\sqrt{-1}$

### Strings

A *string constant* consists of a sequence of characters enclosed in either double-quote or single-quote marks. Strings in double-quotes allow the use of the escape sequences below.

<code>\\</code>	a literal backslash
<code>\"</code>	a literal double-quote character
<code>\'</code>	a literal single-quote character
<code>\n</code>	newline, ASCII code 10
<code>\t</code>	horizontal tab, ASCII code 9
<code>sprintf</code> <code>sscanf</code>	formatted IO to/from string
<code>strcmp</code>	compare strings
<code>strcat</code>	join strings
<code>strfind</code> <code>regex</code>	find matching patterns
<code>strrep</code> <code>regexprep</code>	find and replace patterns

### Index Expressions

<i>var</i> ( <i>idx</i> )	select elements of a vector
<i>var</i> ( <i>idx1</i> , <i>idx2</i> )	select elements of a matrix
<i>var</i> ([1 3], :)	rows 1 and 3
<i>var</i> (:, [2 end])	the second and last columns
<i>var</i> (1:2:end, 2:2:end)	get odd rows and even columns
<i>var</i> 1( <i>var</i> 2 == 0)	elements of <i>var</i> 1 corresponding to zero elements of <i>var</i> 2
<i>var</i> (:)	all elements as a column vector

### Cells, Structures, and Classdefs

<i>var</i> { <i>idx</i> }	= ...	set an element of a cell array
<code>cellfun</code> ( <i>f</i> , <i>c</i> )		apply a function to elements of cell array
<i>var</i> . <i>field</i> = ...		set a field of a structure
<code>fieldnames</code> ( <i>s</i> )		returns the fields of a structure
<code>structfun</code> ( <i>f</i> , <i>s</i> )		apply a function to fields of structure
<code>classdef</code>		define new classes for OOP

### Assignment Expressions

<i>var</i> = <i>expr</i>	assign value to variable
<i>var</i> ( <i>idx</i> ) = <i>expr</i>	only the indexed elements are changed
<i>var</i> ( <i>idx</i> ) = []	delete the indexed elements

### Arithmetic Operators

If two operands are of different sizes, scalars and singleton dimensions are automatically expanded. Non-singleton dimensions need to match.

<i>x</i> + <i>y</i> , <i>x</i> - <i>y</i>	addition, subtraction
<i>x</i> * <i>y</i>	matrix multiplication
<i>x</i> .* <i>y</i>	element-by-element multiplication
<i>x</i> / <i>y</i>	right division, conceptually equivalent to (inverse (y') * x')
<i>x</i> ./ <i>y</i>	element-by-element right division
<i>x</i> \ <i>y</i>	left division, conceptually equivalent to inverse (x) * y
<i>x</i> \ <i>y</i>	element-by-element left division
<i>x</i> ^ <i>y</i>	power operator
<i>x</i> .^ <i>y</i>	element-by-element power operator
<code>+=</code> <code>--</code> <code>*</code> <code>.*</code> <code>/=</code>	in-place equivalents of the above operators
<code>./=</code> <code>\=</code> <code>.\=</code> <code>^=</code> <code>.=</code>	
<code>-x</code>	negation
<code>+x</code>	unary plus (a no-op)
<code>'</code>	complex conjugate transpose
<i>x</i> .'	transpose
<code>++x</code> <code>--x</code>	increment / decrement, return <i>new</i> value
<code>x++</code> <code>x--</code>	increment / decrement, return <i>old</i> value

### Comparison and Boolean Operators

These operators work on an element-by-element basis. Both arguments are always evaluated.

<code>&lt;</code> <code>&lt;=</code> <code>==</code> <code>&gt;=</code> <code>&gt;</code>	relational operators
<code>!=</code> <code>~=</code>	not equal to
<code>&amp;</code>	logical AND
<code> </code>	logical OR
<code>!</code> <code>~</code>	logical NOT

### Short-circuit Boolean Operators

Operators evaluate left-to-right. Operands are only evaluated if necessary, stopping once overall truth value can be determined. Non-scalar operands are converted to scalars with `all`.

<i>x</i> <code>&amp;&amp;</code> <i>y</i>	logical AND
<i>x</i> <code>  </code> <i>y</i>	logical OR

### Operator Precedence

Table of Octave operators, in order of **decreasing** precedence.

<code>()</code> <code>{}</code> <code>.</code>	array index, cell index, structure index
<code>'</code> <code>.'</code> <code>^</code> <code>.^</code>	transpose and exponentiation
<code>+</code> <code>-</code> <code>++</code> <code>--</code> <code>!</code>	unary minus, increment, logical “not”
<code>*</code> <code>/</code> <code>\</code> <code>.*</code> <code>./</code> <code>.\</code>	multiplication and division
<code>+</code> <code>-</code>	addition and subtraction
<code>:</code>	colon
<code>&lt;</code> <code>&lt;=</code> <code>==</code> <code>&gt;=</code> <code>&gt;</code> <code>!=</code>	relational operators
<code>&amp;</code> <code> </code>	element-wise “and” and “or”
<code>&amp;&amp;</code> <code>  </code>	logical “and” and “or”
<code>=</code> <code>+=</code> <code>--</code> <code>*</code> <code>/=</code> etc.	assignment, groups left to right
<code>;</code> <code>,</code>	statement separators

### General programming

endfor, endwhile, endif etc. can all be replaced by end.

<code>for</code> <code>x</code> = 1:10	for loop
<code>endfor</code>	
<code>while</code> ( <code>x</code> <= 10)	while loop
<code>endwhile</code>	
<code>do</code>	do-until loop
<code>until</code> ( <code>x</code> > 10)	
<code>if</code> ( <code>x</code> < 5)	if-then-else
<code>elseif</code> ( <code>x</code> < 6)	
<code>else</code>	
<code>endif</code>	
<code>switch</code> ( <code>tf</code> )	switch-case
<code>case</code> "true"	
<code>case</code> "false"	
<code>otherwise</code>	
<code>endswitch</code>	
<code>break</code>	exit innermost loop
<code>continue</code>	go to start of innermost loop
<code>return</code>	jump back from function to caller
<code>try</code>	cleanup only on exception
<code>catch</code>	
<code>unwind_protect</code>	cleanup always
<code>unwind_protect_cleanup</code>	

### Functions

<code>function</code> <span>[<i>ret-list</i> =]</span> <i>function-name</i> <span>[</span> ( <i>arg-list</i> ) <span>]</span>
<i>function-body</i>
<code>endfunction</code>

*ret-list* may be a single identifier or a comma-separated list of identifiers enclosed by square brackets.

*arg-list* is a comma-separated list of identifiers and may be empty.

### Function Handles and Evaluation

<code>@func</code>	create a function handle to <i>func</i>
<code>@(vars)</code> <i>expr</i>	define an anonymous function
<code>str2func</code> <code>func2str</code>	convert function to/from string

<b>functions</b> ( <i>handle</i> )	Return information about a function handle
<i>f</i> ( <i>args</i> )	Evaluate a function handle <i>f</i>
<b>feval</b>	Evaluate a function handle or string
<b>eval</b> ( <i>str</i> )	evaluate <i>str</i> as a command
<b>system</b> ( <i>cmd</i> )	execute arbitrary shell command string

Anonymous function handles make a copy of the variables in the current workspace at the time of creation.

## Global and Persistent Variables

**global** *var* = ... declare & initialize global variable  
**persistent** *var* = ... persistent/static variable  
Global variables may be accessed inside the body of a function without having to be passed in the function parameter list provided that they are declared global when used.

## Common Functions

<b>disp</b>	display value of variable
<b>printf</b>	formatted output to <b>stdout</b>
<b>input</b> <b>scanf</b>	input from <b>stdin</b>
<b>who</b> <b>whos</b>	list current variables
<b>clear</b> <i>pattern</i>	clear variables matching pattern
<b>exist</b>	check existence of identifier
<b>find</b>	return indices of nonzero elements
<b>sort</b>	return a sorted array
<b>unique</b>	discard duplicate elements
<b>sortrows</b>	sort whole rows in numerical or lexicographic order
<b>sum</b> <b>prod</b>	sum or product
<b>mod</b> <b>rem</b>	remainder functions
<b>min</b> <b>max</b> <b>range</b>	basic statistics
<b>mean</b> <b>median</b> <b>std</b>	

## Error Handling, Debugging, Profiling

<b>error</b> ( <i>message</i> )	print message and return to top level
<b>warning</b> ( <i>message</i> )	print a warning message
<b>debug</b>	guide to all debugging commands
<b>profile</b>	start/stop/clear/resume profiling
<b>profshow</b>	show the results of profiling
<b>profexplore</b>	

## File I/O, Loading, Saving

<b>save</b> <b>load</b>	save/load variables to/from file
<b>save</b> -binary	save in binary format (faster)
<b>dlmread</b> <b>dlmwrite</b>	read/write delimited data
<b>csvread</b> <b>csvwrite</b>	read/write CSV files
<b>xlsread</b> <b>xlswrite</b>	read/write XLS spreadsheets

<b>fopen</b> <b>fclose</b>	open/close files
<b>fprintf</b> <b>fscanf</b>	formatted file I/O
<b>textscan</b>	
<b>fflush</b>	flush pending output

## Math Functions

Run `doc <function>` to find related functions.

<b>cov</b> <b>corrcoef</b>	covariance, correlation coefficient
<b>tan</b> <b>tanh</b> <b>atan2</b>	trig and hyperbolic functions
<b>cross</b> <b>curl</b> <b>del2</b>	vector algebra functions

<b>det</b> <b>inv</b>	determinant matrix inverse
<b>eig</b>	eigenvalues and eigenvectors
<b>norm</b>	vector norm, matrix norm
<b>rank</b>	matrix rank
<b>qr</b>	QR factorization
<b>chol</b>	Cholesky factorization
<b>svd</b>	singular value decomposition

<b>fsolve</b>	solve nonlinear algebraic equations
<b>lsode</b> <b>ode45</b>	integrate nonlinear ODEs
<b>dassl</b>	integrate nonlinear DAEs
<b>integral</b>	integrate nonlinear functions

<b>union</b>	set union
<b>intersection</b>	set intersection
<b>setdiff</b>	set difference

<b>roots</b>	polynomial roots
<b>poly</b>	matrix characteristic polynomial
<b>polyder</b> <b>polyint</b>	polynomial derivative or integral
<b>polyfit</b> <b>polyval</b>	polynomial fitting and evaluation
<b>residue</b>	partial fraction expansion
<b>legendre</b> <b>bessel</b>	special functions

<b>conv</b> <b>conv2</b>	convolution, polynomial multiplication
<b>deconv</b>	deconvolution, polynomial division

<b>fft</b> <b>fft2</b> <b>ifft</b> ( <i>a</i> )	FFT / inverse FFT
<b>freqz</b>	FIR filter frequency response
<b>filter</b>	filter by transfer function

## Plotting and Graphics

<b>plot</b> <b>plot3</b>	2D / 3D plot with linear axes
<b>line</b>	2D or 3D line
<b>patch</b> <b>fill</b>	2D patch, optionally colored
<b>semilogx</b> <b>semilogy</b>	logarithmic axes
<b>loglog</b>	

<b>bar</b> <b>hist</b>	bar chart, histogram
<b>stairs</b> <b>stem</b>	stairsteps and stem graphs
<b>contour</b>	contour plot
<b>mesh</b> <b>trimesh</b> <b>surf</b>	plot 3D surfaces

<b>figure</b>	new figure
<b>hold</b> <b>on</b>	add to existing figure
<b>title</b>	set plot title
<b>axis</b>	set axis range and aspect
<b>xlabel</b> <b>ylabel</b> <b>zlabel</b>	set axis labels
<b>text</b>	add text to a plot
<b>grid</b> <b>legend</b>	draw grid or legend

<b>image</b> <b>imagesc</b> <b>spy</b>	display matrix as image
<b>imwrite</b> <b>saveas</b> <b>print</b>	save figure or image
<b>imread</b>	load an image
<b>colormap</b>	get or set colormap

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