Matlab: Quick Reference

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Matlab is a mathematics-friendly programming language used in the analysis and simulation of data. It has syntactical similarities to C, C++, and Java. This Quick Reference uses Matlab version 6.5 (R13).

How to get HELP

help	display help text at command line.
doc	display HTML docs in the Help browser.
demo	run demonstrations.
open	opens many matlab functions as well as any .m file you create.

Filename Extensions

.m	script or function file
.mat	binary workspace file.
.fig	Matlab figure or GUI template.
.mex	Matlab-executable.

Other Useful Tools

guide	GUI design environment.
simulink	modeling environment.
SPTool	signal processing tool.
FDATool	filter design & analysis tool.

Matlab Editor Key Bindings

Ctrl + R	comment line/block.
Ctrl + T	uncomment line/block.
Ctrl + {	promote indentation.
Ctrl + }	demote indentation.
F5	start execution of script.
Ctrl + s	save file.
Ctrl + f	open find-replace dialog.
Ctrl + b	balance delimiters.

Debugging Hints

dbstop	set debugging stop.
dbclear	clear debugging stop.
dbquit	exit debug mode.

- Remove semicolons at the end of lines to print output to command window.
- Stick to one-function one-task philosophy.
- Comment your m-files thoroughly, including header comments for real-time help later. Use ellipses (…) to continue long lines of code to the next line.
- Try using functions instead of scripts to avoid mangling values of variables.
- Check for function name overloading. Making a variable named 'sum' is a bad idea if you want to use the 'sum' function later in your code.
- Use global variables only when necessary.

Scripts vs. Functions

Scripts contain a list of commands that Matlab simply executes in order. They are useful to batch simple sequences of commonly used commands together. Scripts operate on existing data in the base workspace or on data they create or load.

Functions are m-files that can accept and return arguments. A function operates on variables within its own workspace and is useful for operating repeatedly on data in a specific way.

Code Optimization

'Vectorize' code to speed up processing. Find ways around using for-loops or while-loops.

Anatomy of a function

```
function v = function_name(arg1, arg2)
        v = arg1 + arg2;
return
```

Special Constants

ans	most recent answer.			
eps	smallest floating-point value possible. i.e. 'epsilon'.			
NaN	Not-a-Number.			
pi	i,j	true	false	inf
3.14…	sqrt(-1)	1	0	infinity

Special Characters

%	single-line comment.
'	encloses strings or matrix transpose.
!	Runs OS-level program.
,	Separates matrix column entries.
.	Used in element-wise math ops or separates var names from fieldnames.
;	Suppresses output, or marks end of row.
( )	reference elements of arrays. also used to alter standard order of operation. also encloses parameters during function call.
[ ]	encloses definition of matrix/array.
{ }	define/reference elements of cell array.

Common Object Types

scalar	single value. 1x1 array.
vector	row or col matrices. 1D arrays.
matrix	arrays of 2+ dimensions.
struct	structure array.
cell array	multidim arrays whose elements can be of mixed data/object types.
class	used for object design

Casting Data Types

str2num	convert string to number.
num2str	convert number to string.
int2str	convert integer to string.
double	convert to double precision.
uint8	unsigned 8-bit integer.

Strings

strcmp	compare two strings.
findstr	find string A within string B.
strrep	replace string with another.
concatenate	mystring = [str1 str2];

Printing Output

disp	display string or array.
fprintf	print formatted data to screen/ file.

Function Input/Output

nargin	# of input arguments.
nargout	# of output arguments.
varargin	variable length input argument list as cell array.
varargout	variable length output argument list as cell array.

Colon Operator

count a to b, by stepsize s.	d = a:s:b;
count 1-10	d = 1:10;
0-10, evens	d = 0:2:10;
count down	d = 10:-1:1;

Testing Cases

exist	true if variable is defined.
isempty	true for empty array.
isnan	true for Not-a-Number.
isfield	true if field exists in structure.

Sizing Things

length	length of vector (1D).
size	Size of n-dimensional array.

Manipulating Arrays

zeros	create an array of zeros.
ones	create an array of ones.
repmat	replicate and tile an array.
sort	sort elements.
sortrows	sort rows by a column.
flipud	flip matrices up-down.
concat rows	M = [m1 ; m2]
concat cols	M = [m1 m2]
select row	d = mymatrix(row,:);
delete row	mymatrix(row,:) = [ ];
set row = 5	mymatrix(row,:) = 5;
set col = 5	mymatrix(:,col) = 5;

Operators & Precedence

Precedence levels are defined by each band of contiguous color & are eval. by Matlab from left to right.

( )	parentheses
.'	matrix transpose
.^	power, element-wise
'	complex-conjugate transpose
^	matrix power
+	unary plus
-	unary minus
~	logical negation
.*	multiplication, element-wise.
./	division, element-wise
.\	left-division, element-wise
*	matrix multiplication
/	matrix division
\	matrix left-division
+	addition
-	subtraction
:	colon operator
<	less than
<=	less than or equal to
>	greater than
>=	greater than or equal to
==	equal to
~=	not equal to
&	and, element-wise
|	or, element-wise
=	assign value to …

Flow Control

if… elseif… else… end	if myarmy.size < yourarmy.size
	  a = recruit_forces;
	elseif myarmy.size > yourarmy.size
	  a = begin_invasion;
	else
	  a = init_cheat_seq;
	end

switch… case… end	switch weekday
	  case 'Monday'
	  mood = 'black';
	  case 'Tuesday'
	  mood = 'blue';
	  …
	  otherwise
	  mood = 'green';
	end

while… end	while (~weekend)
	  work_hard_4_the_money();
	end

for… end	for k = 1 : 7 mysevens(k) = 7*k; end
break	break out of while/for-loop.
continue	pass control to next iteration.
pause	wait for time-period or user response.
tic/toc	stopwatch timer.

find

Find is a useful function that searches within a variable without using for-loops. Find operates on a variable and returns the vector containing index values that match its conditional input.

q<10?	idx = find(q<10); my_q = q(idx);
foo == true?	idx = find(foo == true); my_foo = foo(idx);

Handling Errors

warning	display warning message.
error	display msg and abort function.
try … catch… end	exception handling. 'try' a statement, if it returns an error, 'catch' it and do another statement.

File I/O

ls, dir	list directory contents.
load	load workspace or text file from disk.
save	save workspace or text file to disk.
csvread	read comma sep. value file.
csvwrite	write comma sep. value file.
fopen	open file.
fclose	close file.
fread	read binary data from file.
fwrite	write binary data to file.
fprintf	write formatted data to file.

Plotting & Figures

subplot	create axes in tiled positions.
semilogx	log10(x), linear-y 2D plot.
semilogy	linear-x, log10(y) 2D plot.
loglog	log-log scale plot.
plot3	plot lines and points in 3-D.
hist	histogram.
image	display image.
imagesc	scale data and display image.
contour	contour plot.
mesh	3-D mesh surface.
surf	3-D colored surface.

Images

imread	read image from file.
imwrite	write image to file.
imshow	display image from file.
imformats	file format registry.
imadd* imsubtract* immultiply* imdivide*	math functions between two images.
regionprops*	measure properties of image regions.

**requires imaging toolbox.*

Animation

aviinfo	information about AVI file.
avifile	create a new AVI file.
addframe	add a frame to AVI object.
aviread	read/open AVI file.

Common Errors

"*inner matrix dimensions must agree*"
You tried to multiply two matrices. Did you want to multiply them element-by-element?

"*index exceeds matrix dimensions*"
You tried to access an element of an array with an index value that was greater than the size of the array.

"*All matrices on a row in the bracketed expression must have the same number of rows.*"
You tried to concatenate two matrices of dissimilar size. Maybe transpose one?

In an assignment A(:,matrix) = B, the number of rows in A and B must be the same.
Check the sizes of both A and B. Chances are you are trying to set a row or column equal to an element (single value), or an element (single value) to a row or column.

Multidimension Handling

squeeze	remove singleton dimensions. A singleton dimension is any dim for which size(A,dim) = 1.
datagrid	data gridding & surface fitting.
meshgrid	X and Y arrays for 3-D plots.

Standard Math

sqrt	square root.
abs	absolute value.
log	natural logarithm.
log10	base-10 logarithm.
round	round to nearest integer.
floor	round down.
ceil	round up.
rand	uniform dist. random #'s.
randn	Gaussian dist. random #'s.

Complex Math

real	complex real part.
imag	complex imaginary part.
abs	complex modulus.
angle	phase angle.
conj	complex conjugate.

Algebra

roots	find polynomial roots.
poly	convert roots to polynomial.

Trigonometric Functions

sin	asin	tan	atan
cos	acos		atan2

Calculus

diff	numeric/symbolic derivative.
sum	numeric integration.
int	symbolic integration.
gradient	numerical gradient.
divergence	divergence of vector field.
curl	curl of vector field.

Differential Equations

ode23	solve DiffEqs, low order fit.
ode45	solve DiffEqs, med order fit.

Signal Processing

conv	convolution and polynomial multiplication.
xcorr	auto- and cross-correlation
filter	1-D digital filter.
fft	fast-fourier transform
pwelch	power spectral density
tfe	transfer function estimate

Statistics

sum	sum of elements.
nansum*	sum ignoring NaNs.
cumsum	cumulative sum.
mean	average or mean value.
std	standard deviation.
var	variance.
max	largest component.
min	smallest component.
range*	diff between max & min.

** requires Statistics Toolbox.*

Curve Fitting (Regression)

polyfit	fit polynomial to data.
polyval	evaluate polynomial.
corrcoeff	correlation coefficients.
lsqcurvefit	solves non-linear least squares problems.

Symbolic*

syms*	construct symbolic objects.
subs*	symbolic substitution.
simplify*	symbolic simplification.
pretty*	prettily print a symbolic expression.

** requires Symbolic Math Toolbox.*