MATLAB QUICK REFERENCE CARD

Frequently used MATLAB commands – Version v1.0 June 2015

Matlab QRC based on the version by PISM. The original cheat-sheet can be found at: http://www.pism-docs.org/

Getting help

All MATLAB functions have online documentation.

`help command` Help on command

`helpwin` ..... invokes windowed help utility

`doc command` .. Detailed documentation on command (opens in help browser).

Commands and Functions

Three or more periods at the end of a line continue the current command or function call onto the next line. Text on a line after ... is ignored. (Unlike C or Java, in MATLAB a command is normally terminated by a newline character.)

Workspace

`who` ..... lists variables in memory

`whos` ..... lists variable names, sizes, and types in memory

`format` *short*, *long*, *sets* invoke 5, 15, default digit fixed point output style

`clear, clear` *a* clears workspace, variable *a*

`close` *all*, *n* . closes *all* figure windows, window *n*

`Clc` ..... clears command window

`Diary` ..... creates a copy of all commands and most results

`clock, date` .. returns the time, date

`exit, quit` ... terminates MATLAB

File & Folder Operations

`cd` ..... change direction

`copyfile` ..... copy from *pathA* to *pathB*

`dir` ..... output content of a folder

`exist` ..... determines whether variable, function or folder exists

Input and Output

Prompt & Return Data

`disp(`*a*`)` ..... displays the contents of variable *a*

`input('prompt', fmt)` shows prompt for user input

⇒ `interprets input as characterstring and assigns it to` *a*: `a=input('foo: ', s)`

`fprintf(fmt, vars, ..)` formats data and displays the results on the screen (Like the C function *printf*).

⇒ `fprintf('a=%7.5f \n', pi); gives you back: >> a=3.14159`

`sprintf(fmt, vars, ..)` Like *fprintf*, but returns the string instead of printing it to the screen.

Formatstrings

`%d`	integer
`%f`	real number in decimal notation
`%e`	real number in exponential notation
`%g`	real number, optimized notation
`%s`	textstring
`%c`	single character

File Processing

`waitbar` ..... displays progress information.

`error('..'), warning('..')` displays an error message and halts, continues execution.

⇒ `The message can also be a formatting string, followed by the corresponding variables: error('Warning \%d\n', val)`

`save` *foo a b*. saves the variables *a*, *b*, etc. in the file *foo.mat*.

`edit(`*foo*`)` .... opens the specified or nonexistent empty *file* in the Editor.

`open(`*foo.mat*`), load(`*foo.mat*`)` opens file *foo.mat* to command line, additionaly load it into worspace window

⇒ `if` *foo.mat* `contains variables` *x* `and` *y*, `then` *x* `and` *y* `will be accessible as` *a.x* `and` *a.y*: `a = load('foo')`

Slicing and Extracting Data

ATTENTION: It is possible to assign a value to a predefined constant and thus to override its original value (MATLAB will not warn you if you do so).

`size(`*x*`,1)` .... the number of rows of *x*.

`size(`*x*`,2)` .... the number of columns of *x*.

⇒ `the number of rows` *a* `and columns` *b* `of the matrix` *x*: `[a,b]=size(x)`

`numel(`*x*`), nnz(`*x*`)` the number of elements, non-zero elements in *x*.

`length(`*x*`)` .... the length of the vector *x*. For matrices length returns the number of rows or columns, whichever is larger.

`isnumeric(`*x*`), ischar(`*x*`)` tests whether content of *x* is numeric or a character textstring (boolean logic).

Creating Vectors

`linspace(a,b,n)`	a row vector with *n* values linearly spaced from *a* to *b* (inclusive)
`x=[1,2,4,...]`	define a row vector *x* (commata replacable through spacecharacter).
`x=[1; 2; 5; ..]`	define a column vector *x*
`a:c`	the range *a..c*; equivalent to $[a, a+1, ..., c-1, c]$

`a:b:c`	the range $a..c$ with step size b; equivalent to $[a, a+b, a+2*b, ..., c-b, c]$

Indexing vectors

`x(1)`	$1st$ element
`x(n)`	nth element
`x(end)`	last element
`x(1:n)`	first n elements
`x(end-n:end)`	last $n+1$ elements
`x([1 2 4])`	specific elements (use any row or column vector as index)
`x(x>3)`	all elements greater than 3
`x(x>3 & x<5)`	all elements between 3 and 5
`x(:)`	transformed to column vector

Special Characters

`[]`	forms matrices
`()`	used in statements to group operations
`.`	decimal point
`,!`	separates subscripts or matrix elements
`;`	separates rows in a matrix definition or suppresses output
`:`	indicates all rows or all columns
`=`	assignment operator (not equality)
`%`	indicates a comment
`%%`	cell divider

Data Selection and Manipulation

for matrices, the following commands work columnwise.

`min(x), max(x)` the smallest, greatest element of x.

⇒ `returns in addition the position` i `of the greatest element.: [a,i]=max(x)`

`fliplr(x), flipud(x)` reverses the elements of x from left to right, top to bottom.

`sort(x), sortrows(x)` sorts the elements of x in ascending order, as a group and according to the first column.

`sortrows(x,c)` as above, but sorted according to column c. If c is negative, the rows are sorted by descending order. If c is a vector, the rows are sorted first by column $c(1)$, then by column $c(2)$, etc.

`find(x)` ..... returns the indices corresponding to the nonzero entries of x.

⇒ `returns the indices of the positions` j `such that` $x[j] == a[j]$: `find(x==a)`

`unique(x)` .... returns the same values as in a but with no repetitions; the values will also be sorted.

`reshape(x,m,n)` returns the $m \times n$ matrix whose elements are taken columnwise from x.

Math

Basic Math Functions

These are the standard mathematical functions; they always operate pointwise on their arguments.

`sum(x), prod(x)` sum, product of the elements of x

`diff(x)` ..... difference (and sample-wise derivative) of the vector x

`cumsum(x)` .... cumulative sum of the elements of x (and sample-wise integral)

`cumprod(x)` ... same, for the product

`mean(x), median(x)` mean, median of the elements of x

`log(x, base)` computes the logarithm of x with base *base*

`real(x), imag(x)` real, imaginary part of a complex number

`abs(x)` ..... absolute value of x (or complex magnitude if x is a complex number)

`angle(x)` ..... angle in radians of the complex number

`conj(x)` ..... the complex conjugate of x

⇒ `other functions: sin, cos, tan, asin, acos, atan, atan2, log, log10, exp, ..`

Basic Math Operations

`+`	addition
`-`	subtraction
`*`	multiplication
`.*`	array multiplication
`/`	division
`./`	array division
`^`	exponential
`.^`	array exponential

Special Variables & Constants

`i,j`	Imaginary unit squirt: $\sqrt{[-1]}$
`Inf`	Infinity; results e.g. when dividing a non-zero value by zero.
`NaN`	Not a number; results e.g. when computing 0/0.
`ans`	most recent temporary answer
`eps`	Spacing of floating point numbers. Use it to prevent unwanted behavior due to rounding errors.
⇒ `default:`	$2.2204e^{-16}$
`exp(1)`	The base of the natural logarithm.
`flops`	count of floating point operations
`pi`	the math pi (3.1415e)
`realmin, realmax`	smallest, largest real number MATLAB can represent
`intmin, intmax`	returns smallest, largest possible integer used in MATLAB

Relational and Logical Operators

`<`	less than
`<==`	less than or equal to

`>`	greater than
`>==`	greater than or equal to
`==`	equal to
`~=`	not equal to
`&`	and
`!`	or
`~`	not

Matrices

Creating Matrices

`eye(n)` ..... the $n \times n$ identity matrix

`zeros(n)` ..... a $n \times n$ zero matrix

`zeros(m,n)` ... a $m \times n$ zero matrix

`ones(n)` ..... a $n \times n$ all-one matrix

`ones(m,n)` .... a $m \times n$ all-one matrix

`diag(x)` ..... creates a diagonal matrix whose diagonal consists of the entries of vector x

⇒ `transforms the domain specified by vectors` x `and` y `into matrices` X `and` Y `that can be used for the evaluation of functions of two variables: [X,Y]=meshgrid(x,y)`

Matrix Computations

`a+b`	If a and b are $m \times n$ matrices, this is the standard matrix addition. If a is a matrix and b is a scalar, or vice-versa, the scalar is added to every entry of the matrix.
`a-b`	If a and b are $m \times n$ matrices, this is the standard matrix subtraction. If a is a matrix and b is a scalar, or vice-versa, the scalar is subtracted from every entry of the matrix.
`a*b`	If a is an $k \times m$ matrix and b is an $m \times n$ matrix, this is the standard matrix multiplication, i.e., yielding an $k \times m$ matrix. If a is a matrix and b is a scalar, or vice-versa, every element of the matrix is multiplied by the scalar.
`a.*b`	If a and b are $m \times n$ matrices, this is their pointwise multiplication. If either element is a scalar, this is the same as $a * b$.
`a/b`	If a and b are matrices of appropriate dimensions, this is roughly $a * inv(b)$. If b is a scalar, this divides every entry of a by b.
`a./b`	If a and b are $m \times n$ matrices, this is their pointwise division. If a is a scalar, then this divides a by every entry of b. If b is a scalar, then this divides every entry of a by b.
`a\b`	If a is an $n \times n$ matrix and b is an $n \times 1$ column vector, or a matrix with several such columns, then $x = a\backslash b$ is the solution to the equation $a * x = b$. If a is a scalar, then this divides every entry of b by a.
$a.\backslash b$	If a and b are $m \times n$ matrices, this is their left pointwise division. If a is a scalar, then this divides every entry of b by a. If b is a scalar, then this divides b by every entry of a.
$a' * b$	If a and b are $n \times 1$ column vectors, this is their inner product (or scalar product or dot product). (This is not another operator, just a combination of ' (conjugate transpose) and *).
`inv(a)`	The inverse of the $n \times n$ matrix a.
`eig(a)`	is a vector containing the eigenvalues of the $n \times n$ matrix a.

⇒ `produces a diagonal matrix d of eigenvalues and a full matrix` v `whose columns are the corresponding eigenvectors such that` $a * v = v * d$`: [v,d]=eig(a)`

`rank(a)`	is the rank, or number of linearly independent rows or columns of the matrix a.

Indexing matrices

`x'`	the complex conjugate transpose of x
`x.'`	the non-conjugate transpose of x
`x(i,j)`	element at row i, column j
`x(i,:)`	row i
`x(:,j)`	column j
`x(1:m,:)`	first n rows
`x(:,1:n)`	first n columns
`x(end,end)`	The last element in the last row
`x(:)`	transformed to column vector (column by column)

Sparse Matrices

Using sparse matrices can result in a significant computational gain if you work with large matrices that have relatively few non-zero entries.

`sparse(x)` .... converts a sparse or full matrix to sparse

`sparse(m,n)` .. creates an $m \times n$ all-zero sparse matrix

`speye(n)` ..... creates an $n \times n$ sparse identity matrix

`spones(x)` .... creates a matrix with the same sparsity structure as x, but with ones in the nonzero positions.

Signal Processing

`c=conv(a,b)` .. Convolution; e.g., $c(1) = a(1) * b(1)$

`c=xcorr(a,b)` Cross-correlation estimates.

`fft(x)` ..... Fast Fourier Transform of the vector x

`ifft(x)` ..... Inverse Fast Fourier Transform

`fftshift(x)` .. swaps the left and right halves of x to shift the zerofrequency component to the center of the spectrum.

`filter(b,a,x)` filters the data in vector x with the filter described by vectors a and b.

`butter(n,Wn)` designs an nth order lowpass digital Butterworth filter.

⇒ `returns the filter coefficients in the vectors` b `(numerator) and` a `(denominator). The cutoff frequency must be` $0.0 < Wn <$ 1.0, `with` 1.0 `corresponding to half the sample rate: [b,a]=butter(n,Wn)`

`downsample(x,n)` downsamples the signal x by keeping every nth sample starting with the first.

`upsample(x,n)` upsamples the signal x by inserting n zeros between input samples.

`resample(x,p,q)` resamples the signal x at p/q times the original sample rate.

Communication Toolbox

`randint(m,n)` generates an $m \times n$ matrix of random binary numbers.

`randint(m,n,p)` generates an $m \times n$ matrix of random integers between 0 and $p-1$.

`pskmod, pskdemod` phase shift keying modulation, demodulation

`qammod, qamdemod` quadrature amplitude modulation, demodulation

`rcosine` ..... designs a raised or root raised cosine filter

`rcosflt` ..... filters a signal using raised or root raised cosine filter

`awgn` ..... add white Gaussian noise to a signal

`biterr` ..... computes the bit error rate

`symerr` ..... computes the symbol error rate

Charts & Figures

Plotting

`plot(x)` ..... plot of the values of x (on the y-axis) versus $0 : length(x) - 1$

`plot(x,y)` .... bivariate plot of x (on the x-axis) and y (on the y-axis)

`plot(x,y,..)` . allows you to specify formatting options (cf. help plot)

`hist(x)` ..... histogram of the frequencies of x

`stem(..)` ..... is the same as *plot*(..), but the data sequence is plotted as discrete "stems" from the x-axis with circles for the data values.

`semilogy(..)` . is the same as *plot*(..), except a logarithmic (base 10) scale is used for the y-axis.

`scatterplot(x)` generates a scatter plot of x. x can be a real or complex vector, or a two-column matrix with real signal in the first column and imaginary signal in the second column.

Figures

Plots are drawn on figure windows. The following commands control the appearance of figures and plots.

`h=figure` ..... creates a new figure and returns its handle.

`figure(h)` .... makes h the current figure, forces it to become visible, and raises it above all other figures on the screen.

`figure('name', '..')` creates a new figure window with the specified window title

`subplot(m,n,k)` divides the current figure window into $m \times n$ subfigures and selects the kth for the current plot.

`xlabel('..')` . sets the text for the x-axis. *xlabel*, as well as *ylabel*, title etc. accept basic LaTeX -like strings such as $a\hat{}2$ for a^2 or $\backslash alpha$ for α.

`ylabel('..')` . sets the text for the y-axis.

`title('..')` ... sets a title for the current plot.

String Conversions

String to Function/Number

`func2str`	Constructs a function name string from a function handle
`str2func`	Constructs a function handle from a function name string
`int2str`	Integer to string conversion
`mat2str`	Convert a matrix into a string
`num2str`	Number to string conversion
`sprintf`	Write formatted data to a string
`sscanf`	Read string under format control
`str2double`	Convert string to double-precision value
`str2mat`	String to matrix conversion
`str2num`	String to number conversion

Radix Conversion

`bin2dec`	Binary to decimal number conversion
`dec2bin`	Nonnegative integer decimal to binary number conversion
`dec2hex`	Decimal to hexadecimal number conversion
`hex2dec`	Hexadecimal to decimal number conversion
`hex2num`	Hexadecimal to double number conversion

Print & Write Data to File

`csvwrite()` ... write to CSV format in current folder

`print -depsc2 fig.eps` saves the current figure into the file *fig.eps*.

Conditional Statements

```
if expression
    statements
elsif expression
    statements
else expression
    statements
end

switch switch_expression
    statements
case case_expression
    statements
case case_expression
    statements
otherwise
    statements
end

for k = vectorOrColumnList
    statements
end

while logicalExpression
    statements
end
```


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