Color controls.

- `colormap` - Color look-up table.
- `caxis` - Pseudocolor axis scaling.
- `shading` - Color shading mode.

Color maps.

- `hsv` - Hue-saturation-value color map.
- `gray` - Linear gray-scale color map.
- `hot` - Black-red-yellow-white color map.
- `cool` - Shades of cyan and magenta color map.
- `bone` - Gray-scale with a tinge of blue color map.
- `copper` - Linear copper-tone color map.
- `pink` - Pastel shades of pink color map.
- `prism` - Prism color map.
- `jet` - A variant of HSV.
- `flag` - Alternating red, white, blue, and black color map.

Color map related functions.

- `colorbar` - Display color bar (color scale).
- `hsv2rgb` - Hue-saturation-value to red-green-blue conversion.
- `rgb2hsv` - Red-green-blue to hue-saturation-value conversion.
- `contrast` - Gray scale color map to enhance image contrast.
- `brighten` - Brighten or darken color map.
- `spinmap` - Spin color map.
- `rgbplot` - Plot color map.

Lighting models.

- `surfl` - 3-D shaded surface with lighting.
- `specular` - Specular reflectance.
- `diffuse` - Diffuse reflectance.
- `surfnorm` - Surface normals.

Basic operations.

- `max` - Largest component.
- `min` - Smallest component.
- `mean` - Average or mean value.
- `median` - Median value.
<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>std</td>
<td>Standard deviation.</td>
</tr>
<tr>
<td>sort</td>
<td>Sort in ascending order.</td>
</tr>
<tr>
<td>sum</td>
<td>Sum of elements.</td>
</tr>
<tr>
<td>prod</td>
<td>Product of elements.</td>
</tr>
<tr>
<td>cumsum</td>
<td>Cumulative sum of elements.</td>
</tr>
<tr>
<td>cumprod</td>
<td>Cumulative product of elements.</td>
</tr>
<tr>
<td>trapz</td>
<td>Numerical integration using trapezoidal method.</td>
</tr>
</tbody>
</table>

Finite differences.
- **diff**: Difference function and approximate derivative.
- **gradient**: Approximate gradient.
- **del2**: Five-point discrete Laplacian.

Vector operations.
- **cross**: Vector cross product.
- **dot**: Vector dot product.

Correlation.
- **corrcoef**: Correlation coefficients.
- **cov**: Covariance matrix.
- **subspace**: Angle between subspaces.

Filtering and convolution.
- **filter**: One-dimensional digital filter.
- **filter2**: Two-dimensional digital filter.
- **conv**: Convolution and polynomial multiplication.
- **conv2**: Two-dimensional convolution.
- **deconv**: Deconvolution and polynomial division.

Fourier transforms.
- **fft**: Discrete Fourier transform.
- **fft2**: Two-dimensional discrete Fourier transform.
- **ifft**: Inverse discrete Fourier transform.
- **ifft2**: Two-dimensional inverse discrete Fourier transform.
- **abs**: Magnitude.
- **angle**: Phase angle.
- **unwrap**: Remove phase angle jumps across 360 degree boundaries.
- **fftsift**: Move zeroth lag to center of spectrum.
- **cplspair**: Sort numbers into complex conjugate pairs.
- **nextpow2**: Next higher power of 2.
MATLAB/Introduction.

- expo, demo - Start up The MATLAB Expo and display splash screen.
- expomap - Open the MATLAB Expo Main Map (avoids Expo splash screen).

MATLAB/Matrices.

- intro - Introduction to MATLAB.
- inverter - Demonstrate the inversion of a matrix.
- buckydem - Connectivity graph of the Buckminster Fuller geodesic dome.
- sparsity - Demonstrate effect of sparsity orderings.
- matmanip - Introduction to matrix manipulation.
- delsgdemo - Finite difference Laplacian on various domains.
- sepdemo - Separators for a finite element mesh.
- airfoil - Display sparse matrix from NASA airfoil.

MATLAB/Numerics.

- funfuns - Demonstrate functions that operate on other functions.
- fitdemo - Nonlinear curve fit with simplex algorithm.
- sunspots - The answer is 11.08, what is the question?
- e2pi - Which is greater, e^pi or pi^e?
- bench - MATLAB Benchmark.
- odedemo - Ordinary differential equations.
- quaddemo - Adaptive quadrature.
- zerodemo - Zero finding with fzero.
- fplotdemo - Plot a function.
- eigmovie - Symmetric eigenvalue movie.
- rrefmovie - Computation of Reduced Row Echelon Form.
- fftdemo - Use of the fast finite Fourier transform.
- quake - Loma Prieta Earthquake.
- census - Try to predict the US population in the year 2000.
- spline2d - Demonstrate GINPUT and SPLINE in two dimensions.

MATLAB/Visualization.

- graf2d - Demonstrate XY plots in MATLAB.
- graf2d2 - Demonstrate XYZ plots in MATLAB.
- grafcplx - Demonstrate complex function plots in MATLAB.
- lorenz - Plot the orbit around the Lorenz chaotic attractor.
- xpsound - Demonstrate MATLAB V4’s sound capability.
- vibes - Vibrating L-shaped membrane.
- xpklein - Klein bottle demo.
- xfourier - Graphics demo of Fourier series expansion.
- cplxdemo - Maps of functions of a complex variable.
- peaks - A sample function of two
variables.
  *membrane* - Generate MathWorks's logo.
  *penny* - Several views of the penny data.
  *earthmap* - View Earth's topography.
  *sqdemo* - Superquadrics using UIControls.
  *imagedemo* - Demonstrate MATLAB V4's image capability.
  *colormenu* - Select color map.

MATLAB/Language.
  *xplang* - Introduction to the MATLAB language.
  *graf3d* - Demonstrate Handle Graphics for surface plots.
  *hndlgraf* - Demonstrate Handle Graphics for line plots.
  *hndlaxis* - Demonstrate Handle Graphics for axes.

SIMULINK/Simple Systems.
  *simintro* - A quick introduction to SIMULINK.
  *libintro* - A quick introduction to the SIMULINK Libraries.
  *simppend* - SIMULINK system modeling a simple pendulum.
  *onecart* - SIMULINK system modeling a mass-spring system.
  *bounce* - SIMULINK system modeling a bouncing ball.
  *vdp* - SIMULINK system modeling the Van der Pol equations.

SIMULINK/Complex Systems.
  *dblcart1* - SIMULINK system modeling a mass-spring system.
  *dblpend1* - SIMULINK system modeling a double-pendulum system.
  *dblpend2* - SIMULINK system modeling a double-pendulum system.
  *penddemo* - SIMULINK system modeling an inverted pendulum.
  *dblcart* - SIMULINK system modeling a double-cart system.
  *thermo* - SIMULINK system modeling a thermostat heating a house.
  *f14* - SIMULINK system modeling an aircraft in flight.

SIMULINK/Advanced Products.
  *xpaccel* - Provide information about the SIMULINK Accelerator.
  *ccodegen* - Provide information about the C-Code Generator.

Toolbox/Signal Processing.
  *filtdem* - Signal Processing filter demo.
  *filtdem2* - Demonstrate filter design techniques.
  *sigdemo1* - Discrete-time Fourier transform of a signal.
  *sigdemo2* - Continuous-time Fourier transform of a signal.
  *phone* - Signal processing and the touch-tone phone.

Toolbox/System Identification.
  *syiddm* - Identify "hairdryer" system
characteristics.

**iddems** - Set up System Identification command line demos.

**Toolbox/Optimization.**
- **bandem** - Banana function minimization demonstration.
- **optdems** - Set up Optimization command line demos.

**Toolbox/Neural Networks.**
- **bckprp12** - Demonstrate backpropagation.
- **bckprp62** - Demonstrate backpropagation with momentum.
- **neural** - Neural network character recognition.

**Toolbox/Control System.**
- **dskdemo** - Build controller for a disk read/write head.
- **ctrldems** - Set up Control System command line demos.

**Toolbox/Robust Control.**
- **accdm2** - Demo of the 1990 ACC benchmark.
- **rctdems** - Set up Robust Control command line demos.

**Toolbox/Mu-Analysis and Synthesis.**
- **xpmu** - Description of the Mu-Analysis and Synthesis process.
- **mudems** - Set up Mu-Analysis and Synthesis command line demos.

**Toolbox/Spline.**
- **spapidm2** - Demonstrate spline interpolation.
- **spldems** - Set up Spline command line demos.

**Toolbox/Symbolic Math.**
- **xpcalc** - Calculus operations.
- **xpgiv** - Givens transformation.

**Toolbox/Image Processing.**
- **xpimage** - Demonstrate some Image Processing capabilities.

**Toolbox/Statistics.**
- **xppolylt** - Interactively fit a polynomial to noisy data.
- **statdems** - Set up Statistics command line demos.

**Extras/Gallery.**
- **knot** - Tube surrounding a three-dimensional knot.
- **quivdemo** - Demonstrate the quiver function.
- **modes** - Plot 12 modes of the L-shaped membrane.
logo - Display the MATLAB L-shaped membrane logo.
klein1 - Construct a Klein bottle.
cruller - Construct cruller.
tori4 - Construct four linked tori.
spharm2 - Construct spherical surface harmonic.

Extras/Games.
xpbombs - Minesweeper game.
life - Conway's Game of Life.
bblwrap - Bubblewrap.

Extras/Miscellaneous.
truss - Animation of a bending bridge truss.
travel - Traveling salesman problem.
wrldtry - Great circle flight routes around the globe.
makevase - Generate and plot a surface of revolution.
logospin - Movie of The MathWorks' logo spinning.
crulspin - Spinning cruller movie.
xpquad - Superquadrics plotting demonstration.
spinner - Colorful lines spinning through space.

Extras/Contact Info.
contact1 - How to reach The MathWorks, Inc.
contact2 - How to reach The MathWorks, Inc. by email.
contact3 - How to reach international agents for The MathWorks, Inc.
agents - International distributors' locations and contact information.

.c2.14.8.4 Elfun (Elementary Math Functions)

Trigonometric.
sin - Sine.
sinh - Hyperbolic sine.
asin - Inverse sine.
asinh - Inverse hyperbolic sine.
cos - Cosine.
cosh - Hyperbolic cosine.
acos - Inverse cosine.
acosh - Inverse hyperbolic cosine.
tan - Tangent.
tanh - Hyperbolic tangent.
atan - Inverse tangent.
atan2 - Four quadrant inverse tangent.
atanh - Inverse hyperbolic tangent.
sec - Secant.
sech - Hyperbolic secant.
asec - Inverse secant.
asech - Inverse hyperbolic secant.
csc - Cosecant.
csch - Hyperbolic cosecant.
acsc - Inverse cosecant.
acsch - Inverse hyperbolic cosecant.
cot - Cotangent.
coth - Hyperbolic cotangent.
acot - Inverse cotangent.
acoth - Inverse hyperbolic cotangent.

Exponential.
exp - Exponential.
log - Natural logarithm.
log10 - Common logarithm.
sqrt - Square root.

Complex.
abs - Absolute value.
angle - Phase angle.
conj - Complex conjugate.
imag - Complex imaginary part.
real - Complex real part.

Numeric.
fix - Round towards zero.
floor - Round towards minus infinity.
ceil - Round towards plus infinity.
round - Round towards nearest integer.
rem - Remainder after division.
sign - Signum function.

Elmat (Elementary Matrices and Manipulation)

Elementary matrices.
zeros - Zeros matrix.
one - Ones matrix.
eye - Identity matrix.
rand - Uniformly distributed random numbers.
randn - Normally distributed random numbers.
linspace -Linearly spaced vector.
logspace - Logarithmically spaced vector.
meshgrid - X and Y arrays for 3-D plots.
: - Regularly spaced vector.
Special variables and constants.

- **ans**: Most recent answer.
- **eps**: Floating point relative accuracy.
- **realmax**: Largest floating point number.
- **realmin**: Smallest positive floating point number.
- **pi**: 3.1415926535897....
- **i, j**: Imaginary unit.
- **inf**: Infinity.
- **NaN**: Not-a-Number.
- **flops**: Count of floating point operations.
- **nargin**: Number of function input arguments.
- **nargout**: Number of function output arguments.
- **computer**: Computer type.
- **isieee**: True for computers with IEEE arithmetic.
- **isstudent**: True for the Student Edition.
- **why**: Succinct answer.
- **version**: MATLAB version number.

Time and dates.

- **clock**: Wall clock.
- **cputime**: Elapsed CPU time.
- **date**: Calendar.
- **etime**: Elapsed time function.
- **tic, toc**: Stopwatch timer functions.

Matrix manipulation.

- **diag**: Create or extract diagonals.
- **flipr**: Flip matrix in the left/right direction.
- **flipud**: Flip matrix in the up/down direction.
- **reshape**: Change size.
- **rot90**: Rotate matrix 90 degrees.
- **tril**: Extract lower triangular part.
- **triu**: Extract upper triangular part.
- **:** Index into matrix, rearrange matrix.

.c2.14.8.6 Funfun (Function Functions)
Function functions - nonlinear numerical methods.

- **ode23**: Solve differential equations, low order method.
- **ode23p**: Solve and plot solutions.
ode45 - Solve differential equations, high order method.
quad - Numerically evaluate integral, low order method.
quad8 - Numerically evaluate integral, high order method.
fmin - Minimize function of one variable.
fmins - Minimize function of several variables.
fzero - Find zero of function of one variable.
fplot - Plot function.

Managing commands and functions.
help - On-line documentation.
doc - Load hypertext documentation.
what - Directory listing of M-, MAT- and MEX-files.
type - List M-file.
lookfor - Keyword search through the HELP entries.
which - Locate functions and files.
demo - Run demos.
path - Control MATLAB’s search path.

Managing variables and the workspace.
who - List current variables.
whos - List current variables, long form.
load - Retrieve variables from disk.
save - Save workspace variables to disk.
clear - Clear variables and functions from memory.
pack - Consolidate workspace memory.
size - Size of matrix.
length - Length of vector.
disp - Display matrix or text.

Working with files and the operating system.
cd - Change current working directory.
dir - Directory listing.
delete - Delete file.
getenv - Get environment value.
! - Execute operating system command.
unix - Execute operating system command & return result.
diary - Save text of MATLAB session.

Controlling the command window.
cedit - Set command line edit/recall facility parameters.
clc - Clear command window.
home - Send cursor home.
format - Set output format.
echo - Echo commands inside script files.
more - Control paged output in command window.

Starting and quitting from MATLAB.
quit - Terminate MATLAB.
startup - M-file executed when MATLAB is invoked.
matlabrc - Master startup M-file.

General information.
info - Information about MATLAB and The MathWorks, Inc.
subscribe - Become subscribing user of MATLAB.
hostid - MATLAB server host identification number.
whatsnew - Information about new features not yet documented.
ver - MATLAB, SIMULINK, and TOOLBOX version information.

.c2.14.8.8 Graphics (General Purpose Graphics Functions)

Figure window creation and control.
figure - Create Figure (graph window).
gcf - Get handle to current figure.
clf - Clear current figure.
close - Close figure.

Axis creation and control.
subplot - Create axes in tiled positions.
axes - Create axes in arbitrary positions.
gca - Get handle to current axes.
cla - Clear current axes.
axis - Control axis scaling and appearance.
caxis - Control pseudocolor axis scaling.
hold - Hold current graph.

Handle Graphics objects.
figure - Create figure window.
axes - Create axes.
line - Create line.
text - Create text.
patch - Create patch.
surface - Create surface.
image - Create image.
uicontrol - Create user interface control.
uimenu - Create user interface menu.

Handle Graphics operations.
set - Set object properties.
get - Get object properties.
reset - Reset object properties.
delete - Delete object.
gco - Get handle to current object.
drawnow - Flush pending graphics events.
newplot - M-file preamble for NextPlot property.
findobj - Find objects with specified property values.

Hardcopy and storage.
print - Print graph or save graph to file.
printopt - Configure local printer defaults.
orient - Set paper orientation.
capture - Screen capture of current figure.

Movies and animation.
moviein - Initialize movie frame memory.
getframe - Get movie frame.
movie - Play recorded movie frames.

Miscellaneous.
ginput - Graphical input from mouse.
ishold - Return hold state.
graymon - Set graphics window defaults for gray-scale monitors.
rbbox - Rubberband box.
rotate - Rotate an object about a specified direction.
terminal - Set graphics terminal type.
uiputfile - Put up dialog box for saving files.
uigetfile - Put up dialog box which queries for file names.
whitebg - Set graphics window defaults for white background.
zoom - Zoom in and out on a 2-D plot.
waitforbuttonpress - Wait for key/buttonpress over figure.

.c2.14.8.9 Iofun (Low-Level File I/O Functions)

File opening and closing.
open - Open file.
fclose - Close file.

Unformatted I/O.
**Formatted I/O.**

- `fread` - Read binary data from file.
- `fwrite` - Write binary data to file.
- `fscanf` - Read formatted data from file.
- `fprintf` - Write formatted data to file.
- `fgets` - Read line from file, discard newline character.
- `fgetl` - Read line from file, keep newline character.

**File positioning.**

- `ferror` - Inquire file I/O error status.
- `feof` - Test for end-of-file.
- `fseek` - Set file position indicator.
- `ftell` - Get file position indicator.
- `rewind` - Rewind file.

**String conversion.**

- `sprintf` - Write formatted data to string.
- `sscanf` - Read string under format control.

**File Import/Export Routines.**

**WK1 Format.**

- `wk1const` - WK1 record definitions.
- `wk1read` - Read WK1 file/range.
- `wk1write` - Write out matrix in a WK1 formatted file.
- `wk1wrec` - Write a WK1 record header.

**CSV Format.**

- `csvread` - Read Comma Separated Value formatted file into a matrix.
- `csvwrite` - Write out matrix in a CSV formatted file.

**ASCII Delimited Format.**

- `dlmread` - Read ASCII delimited file into a matrix.
- `dlmwrite` - Write out matrix in ASCII delimited file format.

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**.c2.14.8.10 Lang (Language Constructs and Debuggings)**

**MATLAB as a programming language.**

- `script` - About MATLAB scripts and M-files.
- `function` - Add new function.
- `eval` - Execute string with MATLAB expression.
- `feval` - Execute function specified by string.
- `global` - Define global variable.
nargchk - Validate number of input arguments.
lasterr - Last error message.

Control flow.
if - Conditionally execute statements.
else - Used with IF.
elseif - Used with IF.
end - Terminate the scope of FOR, WHILE and IF statements.
for - Repeat statements a specific number of times.
while - Repeat statements an indefinite number of times.
break - Terminate execution of loop.
return - Return to invoking function.
error - Display message and abort function.

Interactive input.
input - Prompt for user input.
keyboard - Invoke keyboard as if it were a Script-file.
menu - Generate menu of choices for user input.
pause - Wait for user response.
uimenu - Create user interface menu.
uicontrol - Create user interface control.

Debugging commands.
dbstop - Set breakpoint.
dbclear - Remove breakpoint.
dbcont - Resume execution.
dbdown - Change local workspace context.
dbstack - List who called whom.
dbstatus - List all breakpoints.
dbstep - Execute one or more lines.
dbtype - List M-file with line numbers.
dbup - Change local workspace context.
dbquit - Quit debug mode.
mexdebug - Debug MEX-files.

.c2.14.8.11 Matfun (Matrix Functions)

Matrix analysis.
cond - Matrix condition number.
norm - Matrix or vector norm.
rcond - LINPACK reciprocal condition estimator.
rank - Number of linearly independent rows or columns.
det - Determinant.
trace - Sum of diagonal elements.
null - Null space.
orth - Orthogonalization.
**rref** - Reduced row echelon form.

**Linear equations.**

\ and / - Linear equation solution; use "help slash".

**chol** - Cholesky factorization.

**lu** - Factors from Gaussian elimination.

**inv** - Matrix inverse.

**qr** - Orthogonal-triangular decomposition.

**qrdelete** - Delete a column from the QR factorization.

**qrinsert** - Insert a column in the QR factorization.

**nnls** - Non-negative least-squares.

**pinv** - Pseudoinverse.

**lscov** - Least squares in the presence of known covariance.

**Eigenvalues** and singular values.

**eig** - Eigenvalues and eigenvectors.

**poly** - Characteristic polynomial.

**polyeig** - Polynomial eigenvalue problem.

**hess** - Hessenberg form.

**rfs2csf** - Real block diagonal form to complex diagonal form.

**cdf2rdf** - Complex diagonal form to real block diagonal form.

**schur** - Schur decomposition.

**balance** - Diagonal scaling to improve eigenvalue accuracy.

**svd** - Singular value decomposition.

**Matrix functions.**

**expm** - Matrix exponential.

**expm1** - M-file implementation of expm.

**expm2** - Matrix exponential via Taylor series.

**expm3** - Matrix exponential via eigenvalues and eigenvectors.

**logm** - Matrix logarithm.

**sqrtm** - Matrix square root.

**funm** - Evaluate general matrix function.

---

.c2.14.8.12 OPS (Operators and Special Characters)

**Arithmetic and Matrix Operators.**

<table>
<thead>
<tr>
<th>Char</th>
<th>Name</th>
<th>HELP topic</th>
</tr>
</thead>
</table>
+     Plus arith
-     Minus arith
*     Matrix multiplication arith
.*    Array multiplication arith
^     Matrix power arith
.^    Array power arith
\     Backslash or left division slash
/     Slash or right division slash
./    Array division slash
kron  Kronecker tensor product kron
:
    Colon
colon

( )     Parentheses paren
[ ]    Brackets paren
.
    Decimal point punct
..    Parent directory punct
...   Continuation punct
,     Comma punct
;     Semicolon punct
%     Comment punct
!     Exclamation point punct
'     Transpose and quote punct
=     Assignment punct
==    Equality relop
< >   Relational operators relop
&     Logical AND relop
|     Logical OR relop
~     Logical NOT relop
xor   Logical EXCLUSIVE OR xor

Logical characteristics.
exist   - Check if variables or functions are defined.
any     - True if any element of vector is true.
all     - True if all elements of vector are true.
find    - Find indices of non-zero elements.
isnan   - True for Not-A-Number.
isinf   - True for infinite elements.
finite  - True for finite elements.
isempty - True for empty matrix.
isreal  - True for real matrix.
isparse - True for sparse matrix.
isstr   - True for text string.
isglobal - True for global variables.

.c2.14.8.13 Plotxy (Two-Dimensional Graphics)
Elementary X-Y graphs.
- `plot` - Linear plot.
- `loglog` - Log-log scale plot.
- `semilogy` - Semi-log scale plot.
- `semilogx` - Semi-log scale plot.
- `fill` - Draw filled 2-D polygons.

Specialized X-Y graphs.
- `polar` - Polar coordinate plot.
- `bar` - Bar graph.
- `stem` - Discrete sequence or "stem" plot.
- `stairs` - Stairstep plot.
- `errorbar` - Error bar plot.
- `hist` - Histogram plot.
- `rose` - Angle histogram plot.
- `compass` - Compass plot.
- `feather` - Feather plot.
- `fplot` - Plot function.
- `comet` - Comet-like trajectory.

Graph annotation.
- `title` - Graph title.
- `xlabel` - X-axis label.
- `ylabel` - Y-axis label.
- `text` - Text annotation.
- `gtext` - Mouse placement of text.
- `grid` - Grid lines.

Plotxyz (Three-Dimensional Graphics)

Line and area fill commands.
- `plot3` - Plot lines and points in 3-D space.
- `fill3` - Draw filled 3-D polygons in 3-D space.
- `comet3` - 3-D comet-like trajectories.

Contour and other 2-D plots of 3-D data.
- `contour` - Contour plot.
- `contour3` - 3-D contour plot.
- `clabel` - Contour plot elevation labels.
- `contourc` - Contour plot computation (used by contour).
- `pcolor` - Pseudocolor (checkerboard) plot.
- `quiver` - Quiver plot.

Surface and mesh plots.
- `mesh` - 3-D mesh surface.
meshc - Combination mesh/contour plot.

meshz - 3-D Mesh with zero plane.
surf - 3-D shaded surface.
surfc - Combination surf/contour plot.
surfl - 3-D shaded surface with lighting.
waterfall - Waterfall plot.

Volume visualization.
slice - Volumetric visualization plots.

Graph appearance.
view - 3-D graph viewpoint specification.
viewmtx - View transformation matrices.
hidden - Mesh hidden line removal mode.
shading - Color shading mode.
axis - Axis scaling and appearance.
caxis - Pseudocolor axis scaling.
colormap - Color look-up table.

graph annotation.
title - Graph title.
xlabel - X-axis label.
ylabel - Y-axis label.
zlabel - Z-axis label for 3-D plots.
text - Text annotation.
gtext - Mouse placement of text.
grid - Grid lines.

3-D objects.
cylinder - Generate cylinder.
sphere - Generate sphere.

c2.14.8.15 Polyfun (Polynomial and Interpolation Functions)

Polynomials.
roots - Find polynomial roots.
poly - Construct polynomial with specified roots.
polyval - Evaluate polynomial.
polyvalm - Evaluate polynomial with matrix argument.
residue - Partial-fraction expansion (residues).

polyfit - Fit polynomial to data.
polyder - Differentiate polynomial.
cconv - Multiply polynomials.
decovn - Divide polynomials.

Data interpolation.
interp1 - 1-D interpolation (1-D table lookup).
interp2 - 2-D interpolation (2-D table lookup).
interpft - 1-D interpolation using FFT method.
griddata - Data gridding.

Spline interpolation.
spline - Cubic spline data interpolation.
ppval - Evaluate piecewise polynomial.

.c2.14.8.16 Sparfun (Sparse Matrix Functions)

Elementary sparse matrices.
speye - Sparse identity matrix.
sprandn - Sparse random matrix.
sprandsym - Sparse symmetric random matrix.
spdias - Sparse matrix formed from diagonals.

Full to sparse conversion.
sparse - Create sparse matrix from nonzeros and indices.
full - Convert sparse matrix to full matrix.
find - Find indices of nonzero entries.
spconvert - Convert from sparse matrix external format.

Working with nonzero entries of sparse matrices.
nz - Number of nonzero entries.
nonzeros - Nonzero entries.
nzmax - Amount of storage allocated for nonzero entries.
spones - Replace nonzero entries with ones.
spaloc - Allocate memory for nonzero entries.
issparse - True if matrix is sparse.
spfun - Apply function to nonzero entries.

Visualizing sparse matrices.
spy - Visualize sparsity structure.
gplot - Plot graph, as in "graph theory".

Reordering algorithms.
colmmd - Column minimum degree.
symmmd - Symmetric minimum degree.
symrcm - Reverse Cuthill-McKee ordering.
colperm - Order columns based on nonzero count.
rperm - Random permutation vector.
dmperm - Dulmage-Mendelsohn decomposition.

Norm, condition number, and rank.

normest - Estimate 2-norm.
condest - Estimate 1-norm condition.
sprank - Structural rank.

Operations on trees.

treelayout - Lay out a tree or forest.
treeplot - Plot a picture of a tree.
etree - Elimination tree of a matrix.
etreeplot - Plot the elimination tree.

Miscellaneous.

symbfact - Symbolic factorization analysis.
spparms - Set parameters for sparse matrix routines.
spaugment - Form least squares augmented system.

c2.14.8.17 Specfun (Specialized Math Function)

besselj - Bessel function of the first kind.
bessely - Bessel function of the second kind.
besseli - Modified Bessel function of the first kind.
besselk - Modified Bessel function of the second kind.
beta - Beta function.
betainc - Incomplete beta function.
betaln - Logarithm of beta function.
ellipj - Jacobi elliptic functions.
ellipke - Complete elliptic integral.
erf - Error function.
erfc - Complementary error function.
erfcx - Scaled complementary error function.
erfinv - Inverse error function.
expi - Exponential integral function.
gamma - Gamma function.
gcd - Greatest common divisor.
gammainc - Incomplete gamma function.
lcm - Least common multiple.
legendre - Associated Legendre function.
gammainc - Logarithm of gamma function.
log2 - Dissect floating point numbers.
pow2 - Scale floating point numbers.
rats - Rational approximation.
rats - Rational output.
cart2sph - Transform from Cartesian to spherical coordinates.
cart2pol - Transform from Cartesian to
polar coordinates.

\texttt{pol2cart} - Transform from polar to Cartesian coordinates.
\texttt{sph2cart} - Transform from spherical to Cartesian coordinates.

.c2.14.8.18 Specmat (Specialized Matrices)

\texttt{compan} - Companion matrix.
\texttt{gallery} - Several small test matrices.
\texttt{hadamard} - Hadamard matrix.
\texttt{hankel} - Hankel matrix.
\texttt{hilb} - Hilbert matrix.
\texttt{invhilb} - Inverse Hilbert matrix.
\texttt{kron} - Kronecker tensor product.
\texttt{magic} - Magic square.
\texttt{pascal} - Pascal matrix.
\texttt{rosser} - Classic symmetric eigenvalue test problem.
\texttt{toeplitz} - Toeplitz matrix.
\texttt{vander} - Vandermonde matrix.
\texttt{wilkinson} - Wilkinson's eigenvalue test matrix

.c2.14.8.19 Sounds (Sound Processing Functions)

General sound functions.
\texttt{sound} - Convert vector into sound.
\texttt{saxis} - Sound axis scaling.

\texttt{Computer} - specific sound functions.
\texttt{auwrite} - Write mu-law encloded audio file.
\texttt{auread} - Read mu-law encloded audio file.
\texttt{wavwrite} - Write MS Windows .WAV audio file.
\texttt{wavread} - Read MS Windows .WAV audio file.
\texttt{mu2lin} - Mu-law to linear conversion.
\texttt{lin2mu} - Linear to mu-law conversion.

.c2.14.8.20 Strfun (Character String Functions)

General.
\texttt{strings} - About character strings in MATLAB.
\texttt{abs} - Convert string to numeric values.
\texttt{setstr} - Convert numeric values to string.
\texttt{isstr} - True for string.
\texttt{blanks} - String of blanks.
\texttt{deblank} - Remove trailing blanks.
\texttt{str2mat} - Form text matrix from
individual strings.

`eval` - Execute string with MATLAB expression.

String comparison.

`strcmp` - Compare strings.
`findstr` - Find one string within another.
`upper` - Convert string to uppercase.
`lower` - Convert string to lowercase.
`isletter` - True for letters of the alphabet.
`isspace` - True for white space characters.
`strrep` - Replace a string with another.
`strtok` - Find a token in a string.

String to number conversion.

`num2str` - Convert number to string.
`int2str` - Convert integer to string.
`str2num` - Convert string to number.
`sprintf` - Convert number to string under format control.
`sscanf` - Convert string to number under format control.

Hexadecimal to number conversion.

`hex2num` - Convert hex string to IEEE floating point number.
`hex2dec` - Convert hex string to decimal integer.
`dec2hex` - Convert decimal integer to hex string.

影像與 MATLAB

```matlab
w=imread('wombat.tif');
figure, imshow(w), pixval on

size(w)

imfinfo('emu.tif')
```

影像格式: JPEG、TIFF、GIF、BMP、PNG、HDF、PCX、ICO、CUR、HDF
影像顯示

點 處 理

1. 數學運算

```matlab
b = imread('blocks.tif');

b1 = b + 128  

y = x + 128:  b1 = unit(double(b) + 128)  or b1 = imadd(b, 128)  
y = x - 128:  b2 = imsubtract(b, 128)  
imshow(b1), figure, imshow(b2)

y = x/2:  b3 = immultiply(b, 0.5); or b3 = imdivide(b, 2);  
y = 2x:  b4 = immultiply(b, 2);  
y = x/2 + 128:  b5 = imadd(immultiply(b, 0.5), 128);  
            or b5 = imadd(imdivide(b, 2), 128);
```

2. 補色

```matlab
y = 255 - x:  bc = imcomplement(b);  
imshow(bc)
```

3. 直方圖(灰階值分佈圖)

```matlab
p = imread('pout.tif');  
imshow(p), figure, imhist(p), axis tight
```

4. 擴展其灰階
imadjust(im, [a b], [c d])

t=imread('tire.tif');
ths=imadjust(t, [], [], 0.5);
imshow(t), figure, imshow(th)

plot(t, th, 'o'), axis tight

5. 直方圖等化(equalization)

p=imread('pout.tif');
ph=histeq(p);
imshow(p), figure, imhist(ph), axis tight

en=imread('engineer.tif');
e=imdivide(en, 4);
imshow(e), figure, imhist(e), axis tight
eh=histeq(e);
imshow(eh), figure, imhist(eh), axis tight