Matlab

- Generalità :
  - Cosa è Matlab
  - L'ambiente a riga di comando

General Purpose Commands

Managing Commands and Functions	
demo	Run demos.
help	Online documentation.
info	Information about MATLAB and The MathWorks.
lookfor	Keyword search through the help entries.
path	Control MATLAB's search path.
type	List M-file.
what	Directory listing of M-, MAT- and MEX-files.
which	Locate functions and files.

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

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

- Operazioni Elementari :

```
» 5+4
ans =
     9

» a=4
a =
     4

» b=5;

» c=a+b;

» c
c =
     9
```

Operators and Special Characters

Operators and Special Characters	
+	Plus.
-	Minus.
*	Matrix multiplication.
.*	Array multiplication.
^	Matrix power.
.^	Array power.
kron	Kronecker tensor product.
\	Backslash or left division.
/	Slash or right division.
./	Array division.
:	Colon.
()	Parentheses.
[]	Brackets.
.	Decimal point.
..	Parent directory.
...	Continuation.
,	Comma.
;	Semicolon.
%	Comment.
!	Exclamation point.
'	Transpose and quote.
.'	Nonconjugated transpose.
=	Assignment.
==	Equality.
<>	Relational operators.
&	Logical AND.
|	Logical OR.
~	Logical NOT.
xor	Logical EXCLUSIVE OR.

- COSTANTI PREDEFINITE

» pi

ans =

3.1416

Special Variables and Constants	
ans	Most recent answer.
computer	Computer type.
eps	Floating point relative accuracy.
flops	Count of floating point operations.
i, j	Imaginary unit.
inf	Infinity.
NaN	Not-a-Number.
nargin	Number of function input arguments.
nargout	Number of function output arguments.
pi	3.1415926535897....
realmax	Largest floating point number.
realmin	Smallest floating point number

Time and Dates	
clock	Wall clock.
cputime	Elapsed CPU time.
date	Calendar.
etime	Elapsed time function.
tic, toc	Stopwatch timer functions.

- FUNZIONI PREDEFINITE

```
» sqrt(9)

ans =

    3

» exp(1)

ans =

   2.7183

» log(exp(1))

ans =

    1

» log10(100)

ans =
2
```

Elementary Functions

Elementary Math Functions	
abs	Absolute value.
acos	Inverse cosine.
acosh	Inverse hyperbolic cosine.
angle	Phase angle.
asin	Inverse sine.
asinh	Inverse hyperbolic sine.
atan	Inverse tangent.
atan2	Four quadrant inverse tangent.
atanh	Inverse hyperbolic tangent.
ceil	Round towards plus infinity.
conj	Complex conjugate.
cos	Cosine.
cosh	Hyperbolic cosine.
exp	Exponential.
fix	Round towards zero.
floor	Round towards minus infinity.
imag	Complex imaginary part.
log	Natural logarithm.
log10	Common logarithm.
real	Complex real part.
rem	Remainder after division.
round	Round towards nearest integer.
sign	Signum function.
sin	Sine.
sinh	Hyperbolic sine.
sqrt	Square root.
tan	Tangent.
tanh	Hyperbolic tangent.

- Il linguaggio di programmazione MatLab

```
echo on;

% Questo File è una dimostrazione del linguaggio Matlab

pause


t=0:.1:4*pi;

y=sin(t);

for i=1:size(t,2),
                if y(i)>0, yf(i)=y(i)^2;
                        else yf(i)=0;
                        end;
end;

plot(t,yf);
```

- Funzioni Matlab

```
function [pos,num]=numuno(vettore)

n = size(vettore,2);
num=0;
for i=1:n,
        if vettore(i)==1, num=num+1;pos(num)=i;end;
end;
```

```
» v=[0 1 1 1 0 0 1 0];
» [pos,num]=numuno(v);
» pos

pos =

    2    3    4    7
» num
num =     4
```

Language Constructs and Debugging

MATLAB as a Programming Language	
`eval`	Execute string with MATLAB expression.
`feval`	Execute function specified by string.
`function`	Add new function.
`global`	Define global variable.
`nargchk`	Validate number of input arguments.

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

Function Functions

Function Functions - Nonlinear Numerical Methods	
`fmin`	Minimize function of one variable.
`fmins`	Minimize function of several variables.
`fplot`	Plot function.
`fzero`	Find zero of function of one variable.
`ode23`	Solve differential equations, low order method.
`ode45`	Solve differential equations, high order method.
`quad`	Numerically evaluate integral, low order method.
`quad8`	Numerically evaluate integral, high order method.

- I Vettori In MatLab :

- Importanza dei vettori in Matlab

- Manipolazione di Vettori :

```
» v=[0 1 1 1 0 0 1 0]

v =

    0    1    1    1    0    0    1    0

» v=[0;1;1;1;0;0;1;0]

v =

    0
    1
    1
    1
    0
    0
    1
    0


» a=[1 2 3];
» b=[4 5 6];
» a.*b

ans =

    4   10   18

» a+b

ans =

    5    7    9

» a(1:2)

ans =
    1    2
```

```
» sum(a)

ans =

    6

» max(a)

ans =

    3

» min(b)

ans =

    4
```

Basic Operations	
`cumprod`	Cumulative product of elements.
`cumsum`	Cumulative sum of elements.
`max`	Largest component.
`mean`	Average or mean value.
`median`	Median value.
`min`	Smallest component.
`prod`	Product of elements.
`sort`	Sort in ascending order.
`std`	Standard deviation.
`sum`	Sum of elements.
`trapz`	Numerical integration using trapezoidal method.

- Rappresentazione dei Polinomi :

$$x^2 + 3 \cdot x + 2$$

```
» p=[1 3 2];
» polyval(p,1)
ans =

    6

» polyval(p,2)
ans =

   12

» polyval(p,3)
ans =

   20

» p1=[1 2 3];
» p2=[6 12 20];


» inter=polyfit(p1,p2,2)

inter =

   1.0000    3.0000    2.0000
```

- Prodotto di due Polinomi :

$$\left(x^2 + 2 \cdot x + 1\right) \cdot \left(x^2 + 4 \cdot x + 4\right)$$

```
» pol1=[1 2 1];
» pol2=[1 4 4];
» prod=conv(pol1,pol2)

prod =

    1    6   13   12    4
```

- Segnali come vettori :

```
» T=0.1;
» t=0:T:1;
» y=sin(t);
» y

y =

 Columns 1 through 7

    0    0.0998    0.1987    0.2955    0.3894    0.4794    0.5646

 Columns 8 through 11

  0.6442    0.7174    0.7833    0.8415
```

Polynomials	
conv	Multiply polynomials.
deconv	Divide polynomials.
poly	Construct polynomial with specified roots.
polyder	Differentiate polynomial (see online help).
polyfit	Fit polynomial to data.
polyval	Evaluate polynomial.
polyvalm	Evaluate polynomial with matrix argument.
residue	Partial-fraction expansion (residues).
roots	Find polynomial roots.

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

- Visualizzazione :

```
» t=0:.1:1;
» y=humps(t);
» plot(t,y)
» t=0:.01:1;
» y=humps(t);
» plot(t,y)
» grid
» axis([0.2 0.4 50 100])
» clf
```

- Plotting di funzioni definite dall'utente

- Definizione della funzione sinc

```
function y=sinc(x)
y=sin(x)./x;
```

```
» fplot('sinc',[-30 30])
» fplot('sinc',[-30 30],'-o')
» fplot('sinc',[-30 30],'-o')
» fplot('sinc',[-30 30],'-x')
» fplot('sinc',[-30 30],'x')
» fplot('sinc',[-30 30],'+-')
» fplot('sinc',[-30 30],'-+')
```

- Plotting in 3D

$$z = \frac{sin\left(\sqrt{x^2 + y^2}\right)}{\sqrt{x^2 + y^2}}$$

```
» x=-10:.3:10;
» y=-10:.3:10;
» [X,Y]=meshgrid(x,y);
» ro=sqrt(X.^2+Y.^2);
» z=sin(ro)./ro;
» surf(x,y,z)
» shading flat
» view([0 -10 0.5])
» view([0 -10 0.8])
```

Figure Window Creation and Control	
clf	Clear current figure.
close	Close figure.
figure	Create Figure (graph window).
gcf	Get handle to current figure.

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

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

Handle Graphics Operations	
delete	Delete object.
drawnow	Flush pending graphics events.
get	Get object properties.
reset	Reset object properties.
set	Set object properties.

Hardcopy and Storage	
orient	Set paper orientation.
print	Print graph or save graph to file.
printopt	Configure local printer defaults.

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

Miscellaneous	
ginput	Graphical input from mouse.
ishold	Return hold state.

Two Dimensional Graphics

Elementary X-Y Graphs	
`fill`	Draw filled 2-D polygons.
`loglog`	Log-log scale plot.
`plot`	Linear plot.
`semilogx`	Semi-log scale plot.
`semilogy`	Semi-log scale plot.

Specialized X-Y Graphs	
`bar`	Bar graph.
`compass`	Compass plot.
`errorbar`	Error bar plot.
`feather`	Feather plot.
`fplot`	Plot function.
`hist`	Histogram plot.
`polar`	Polar coordinate plot.
`rose`	Angle histogram plot.
`stairs`	Stairstep plot.

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

- MATRICI

```
» A=[1 2 3;2 3 4]

A =

     1     2     3
     2     3     4

» B=magic(8)

B =

    64     2     3    61    60     6     7    57
     9    55    54    12    13    51    50    16
    17    47    46    20    21    43    42    24
    40    26    27    37    36    30    31    33
    32    34    35    29    28    38    39    25
    41    23    22    44    45    19    18    48
    49    15    14    52    53    11    10    56
     8    58    59     5     4    62    63     1

» C=eye(3)
C =
     1     0     0
     0     1     0
     0     0     1

» D=zeros(3)
D =
     0     0     0
     0     0     0
     0     0     0

» E=ones(3)
E =

     1     1     1
     1     1     1
     1     1     1
```

```
» A=magic(3)
A =
     8     1     6
     3     5     7
     4     9     2

» A'
ans =
     8     3     4
     1     5     9
     6     7     2

» inv(A)
ans =
    0.1472   -0.1444    0.0639
   -0.0611    0.0222    0.1056
   -0.0194    0.1889   -0.1028

» det(A)
ans =
  -360

» [avet,aval]=eig(A);
» avet
avet =
   -0.5774   -0.8131   -0.3416
   -0.5774    0.4714   -0.4714
   -0.5774    0.3416    0.8131

» aval
aval =
   15.0000         0         0
         0    4.8990         0
         0         0   -4.8990

» svd(A)
ans =
   15.0000
    6.9282
    3.4641
```

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

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

Linear Equations	
chol	Cholesky factorization.
inv	Matrix inverse.
lscov	Least squares in the presence of known covariance.
lu	Factors from Gaussian elimination.
nnls	Non-negative least-squares.
pinv	Pseudoinverse.
qr	Orthogonal-triangular decomposition.
\ and /	Linear equation solution.

Eigenvalues and Singular Values	
balance	Diagonal scaling to improve eigenvalue accuracy.
cdf2rdf	Complex diagonal form to real block diagonal form.
eig	Eigenvalues and eigenvectors.
hess	Hessenberg form.
poly	Characteristic polynomial.
qz	Generalized eigenvalues.
rsf2csf	Real block diagonal form to complex diagonal form.
schur	Schur decomposition.
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.
funm	Evaluate general matrix function.
logm	Matrix logarithm.
sqrtm	Matrix square root.

- NUMERI COMPLESSI

```
» x=1+2j;
» conj(x)
ans =
   1.0000 - 2.0000i

» real(x)
ans =
     1

» imag(x)
ans =
     2

» abs(x)
ans =
   2.2361

» sqrt(5)
ans =
   2.2361

» angle(x)
ans =
   1.1071

» 1+3j+3+4j
ans =
   4.0000 + 7.0000i

» 1/3j
ans =
       0 - 0.3333i

» j^2
ans =
  -1.0000 + 0.0000i

» 1+2j/3+.8j
ans =
   1.0000 + 1.4667i
```