Laboratorio di Immagini

Esercitazione 1:

Introduzione a MATLAB

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09/03/2016

MATLAB

Cos’è MATLAB?

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- MATLAB **non** è un linguaggio di programmazione

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- MATLAB è un ambiente per il calcolo numerico, al cui interno contiene un linguaggio di programmazione proprietario

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- MATLAB **non** è un linguaggio di programmazione
- MATLAB è un ambiente per il calcolo numerico, al cui interno contiene un linguaggio di programmazione proprietario
- MATLAB è disponibile sia per sistemi Unix (Mac Os e Linux) sia per Windows

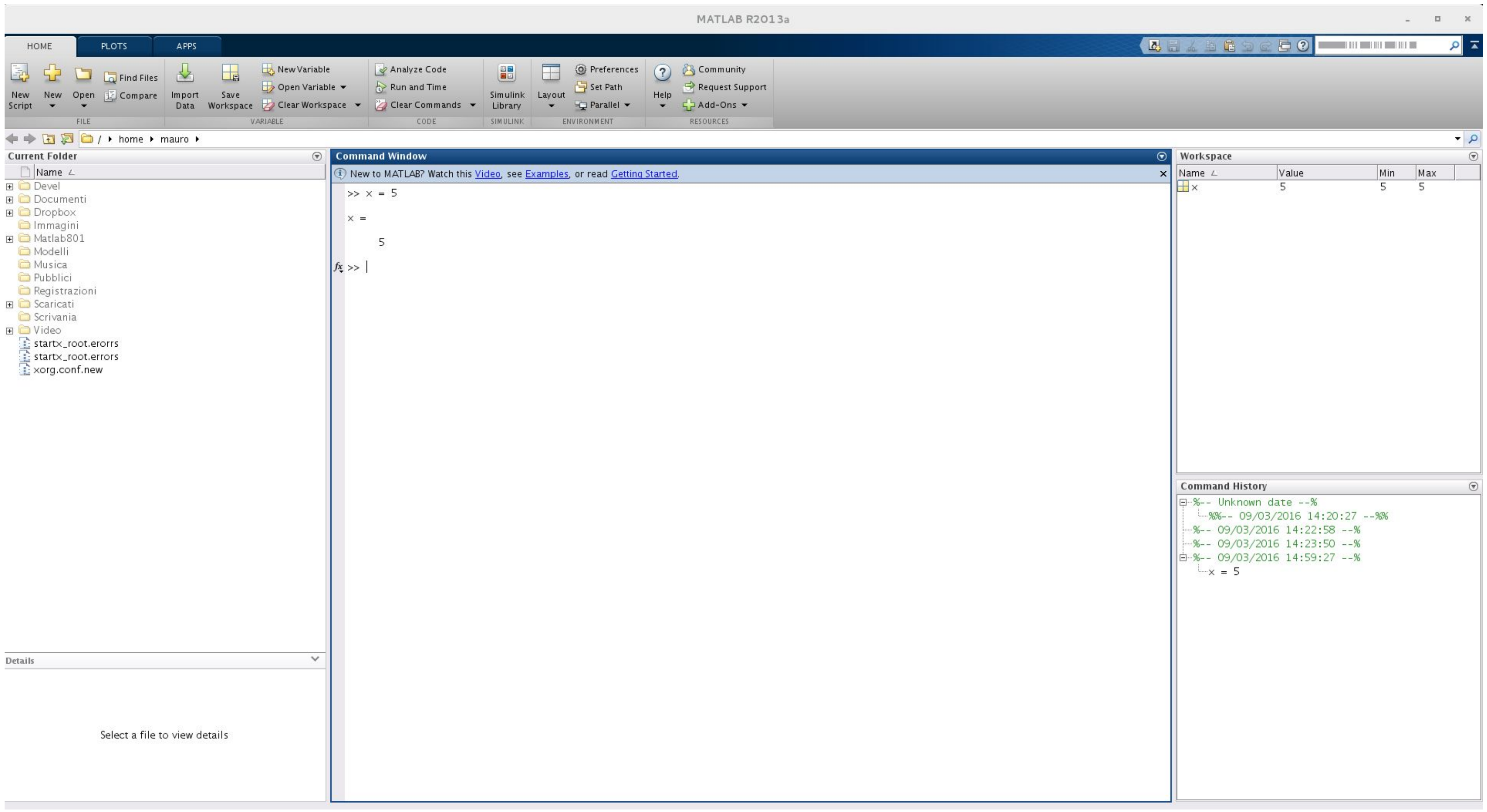
MATLAB

- **MATLAB** è la contrazione delle parole ***MAT****rix* ***LAB****oratory*

MATLAB

- **MATLAB** è la contrazione delle parole ***MAT**rix* ***LAB**oratory*
- Come si evince dal nome, MATLAB è stato progettato per il calcolo matriciale ed è particolarmente efficiente nello svolgimento di questi calcoli

L’interfaccia di MATLAB



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- startx_root.errors
- xorg.conf.new

Details

Select a file to view details

Command Window

New to MATLAB? Watch this Video, see Examples, or read Getting Started.

```
>> x = 5

x =

     5

>> 
```

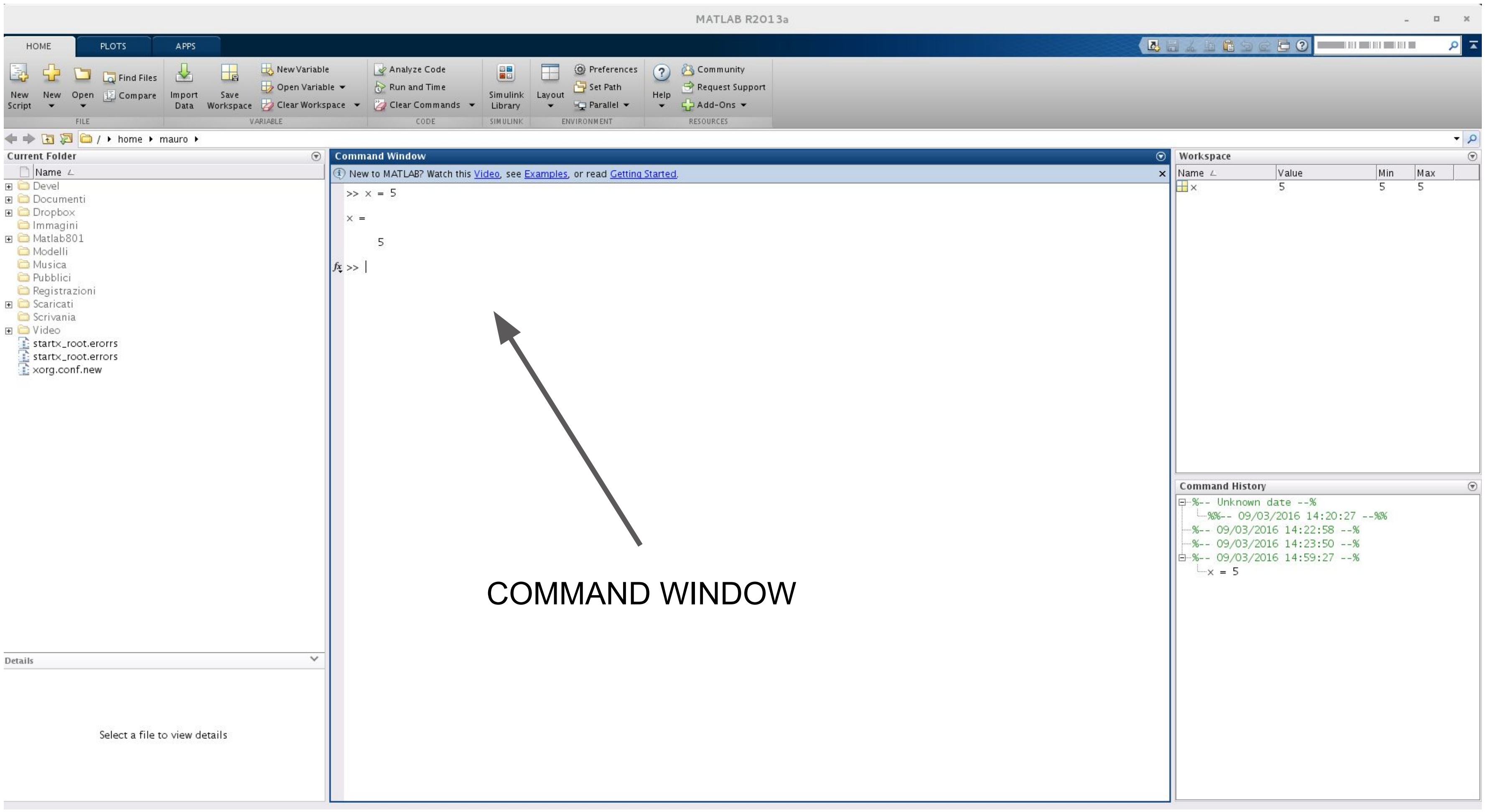
Workspace

Name	Value	Min	Max
x	5	5	5

Command History

```
%-- Unknown date --%
  %%-- 09/03/2016 14:20:27 --%%
%-- 09/03/2016 14:22:58 --%
%-- 09/03/2016 14:23:50 --%
%-- 09/03/2016 14:59:27 --%
  x = 5
```

L’interfaccia di MATLAB



New to MATLAB? Watch this Video, see Examples, or read Getting Started.

```
>> x = 5

x =

     5

fx >> |
```

Name	Value	Min	Max
x	5	5	5

```
%-- Unknown date --%
  %%-- 09/03/2016 14:20:27 --%%
%-- 09/03/2016 14:22:58 --%
%-- 09/03/2016 14:23:50 --%
%-- 09/03/2016 14:59:27 --%
  x = 5
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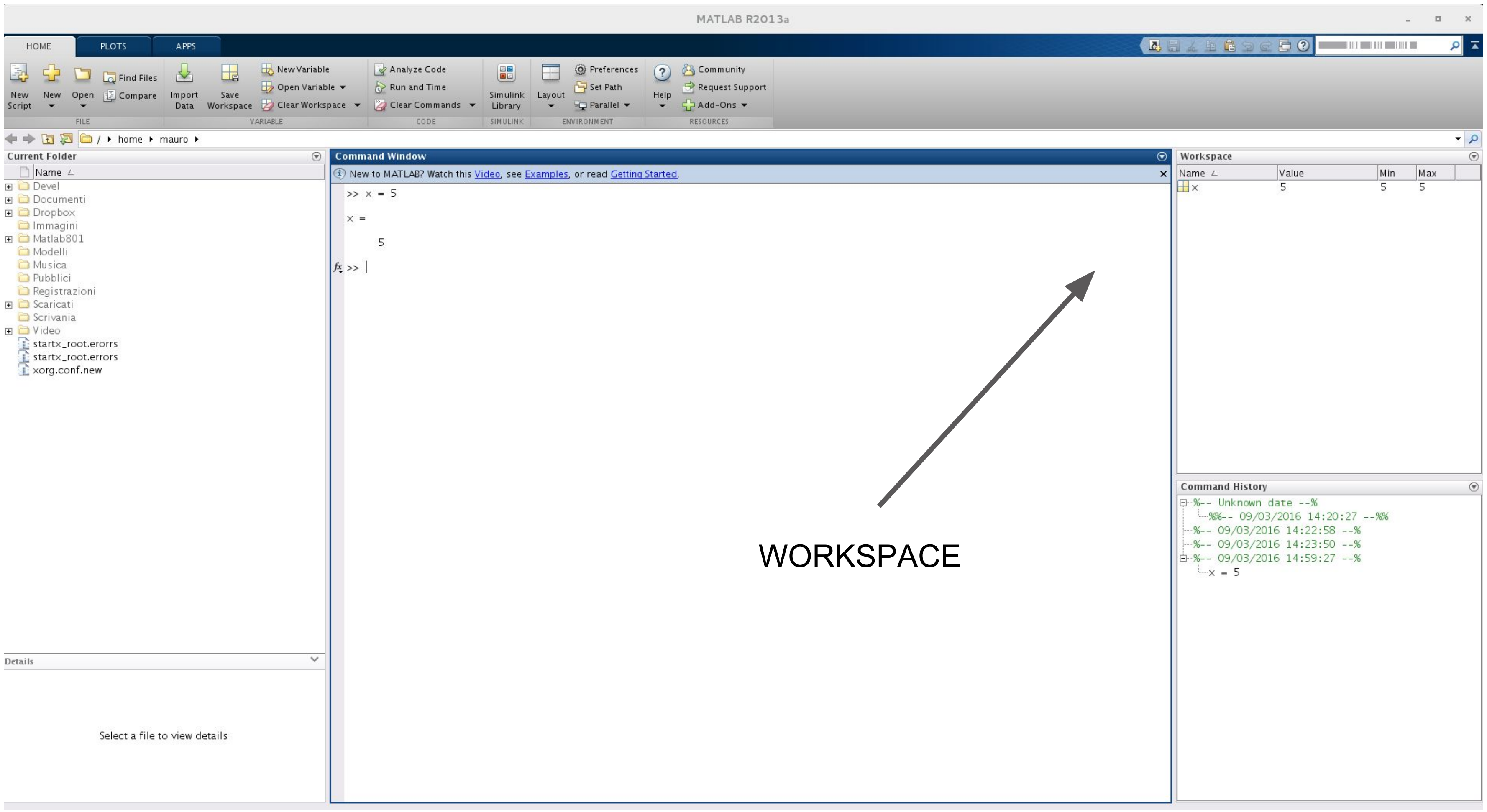
COMMAND WINDOW

L’interfaccia di MATLAB



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```
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x =

     5

fx >> |
```

Name	Value	Min	Max
x	5	5	5

```
%-- Unknown date --%
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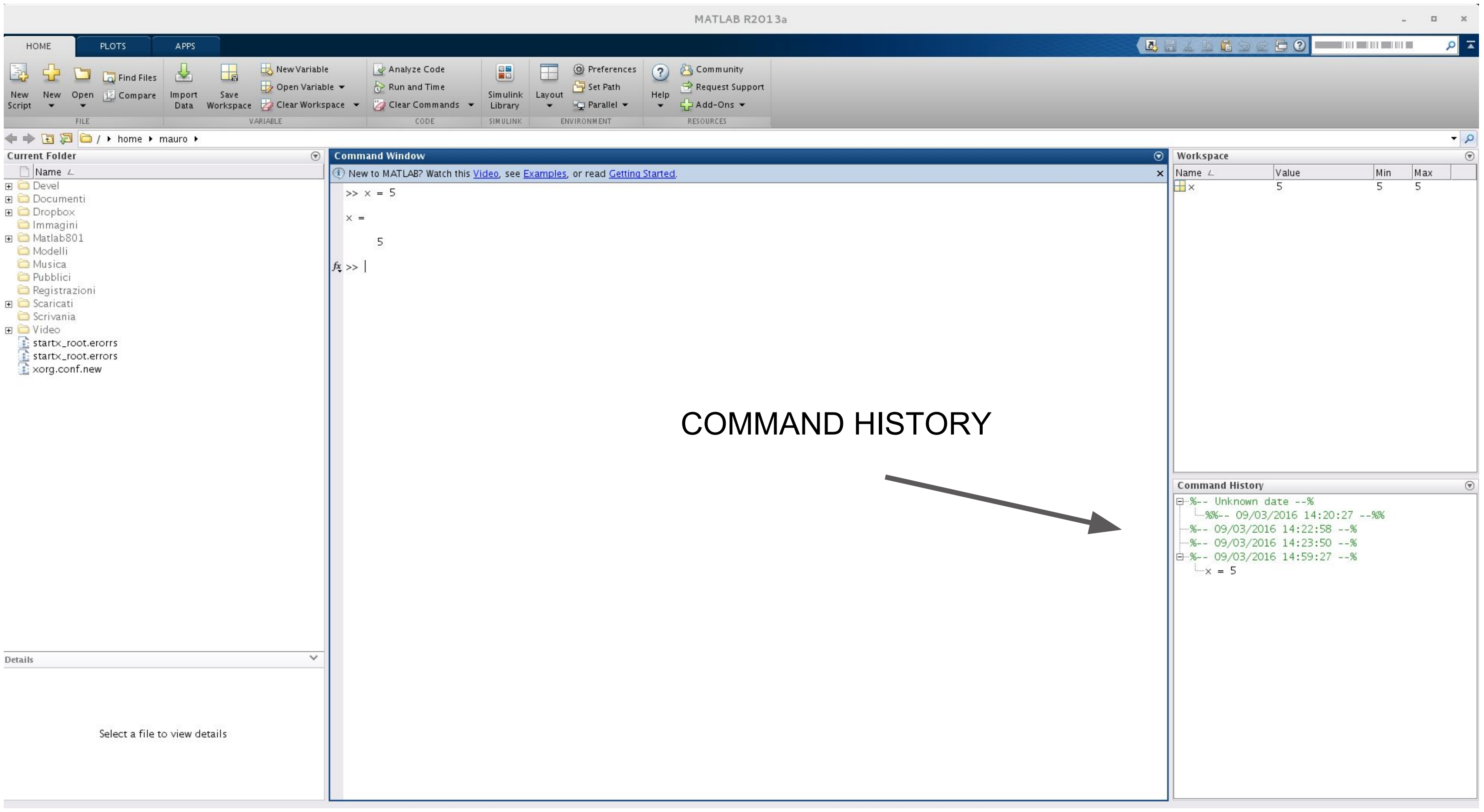
L’interfaccia di MATLAB



```
>> x = 5

x =

     5

fx >> |
```

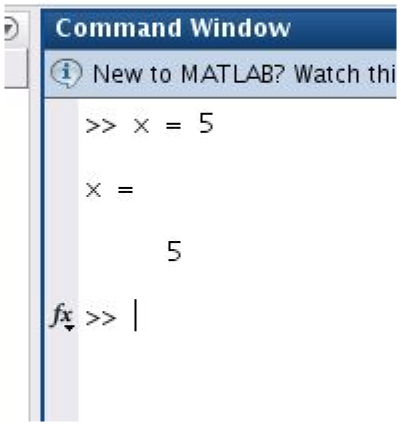
Name	Value	Min	Max
x	5	5	5

```
⊟-%-- Unknown date --%
   └%%-- 09/03/2016 14:20:27 --%%
 -%-- 09/03/2016 14:22:58 --%
 -%-- 09/03/2016 14:23:50 --%
⊟-%-- 09/03/2016 14:59:27 --%
   └x = 5
```

COMMAND HISTORY

MATLAB: comandi base

Dichiarazione di una variabile:

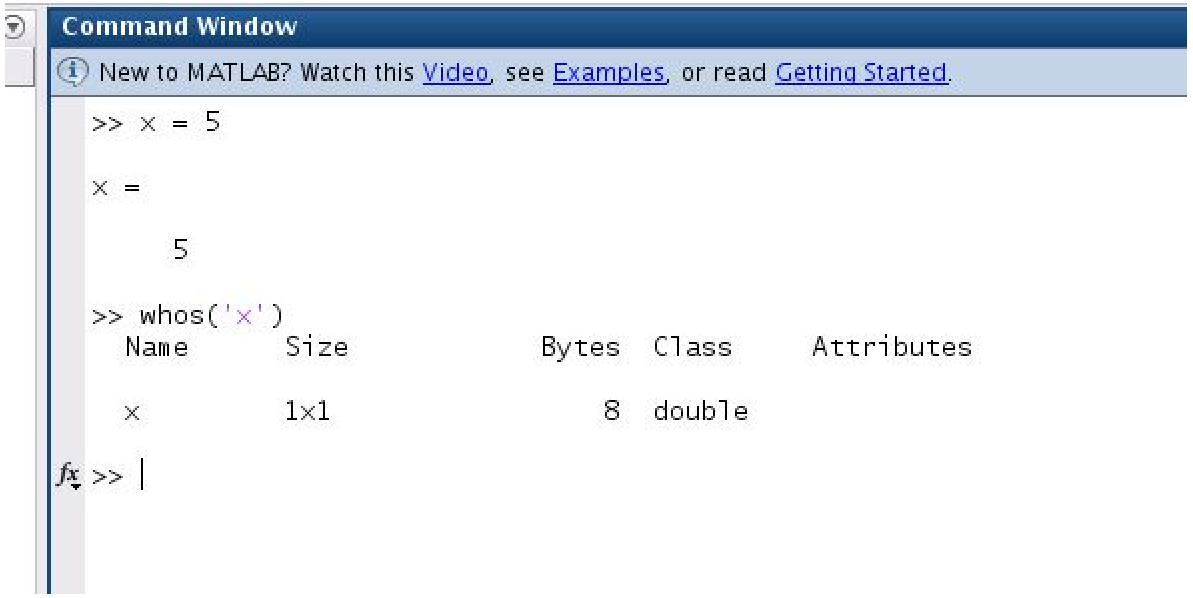


```
>> x = 5

x =

     5

>> |
```

Le variabili in MATLAB non vanno dichiarate con il “tipo”

MATLAB: comandi base

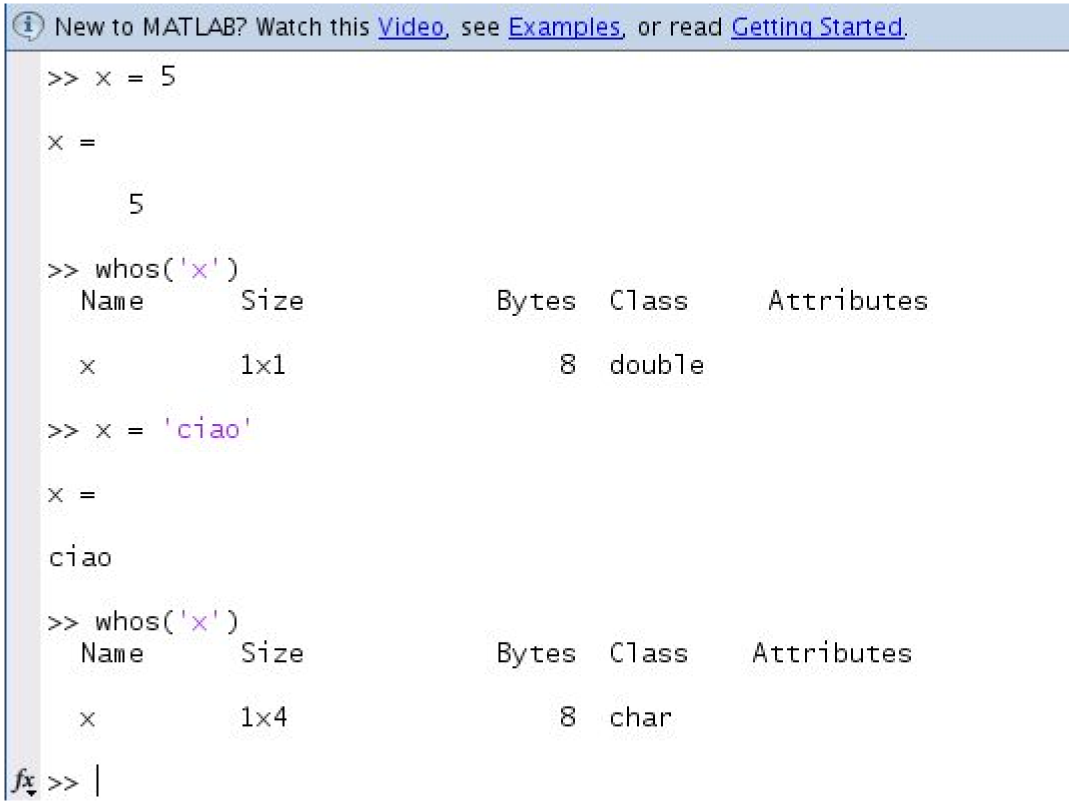
MATLAB è tipizzato implicitamente (a volte è più un problema che un vantaggio)


Command Window
New to MATLAB? Watch this Video, see Examples, or read Getting Started.

```
>> x = 5

x =

     5

>> whos('x')
  Name      Size            Bytes  Class     Attributes

  x         1x1                 8  double

>> 
```

MATLAB: comandi base

La stessa variabile può essere riciclata

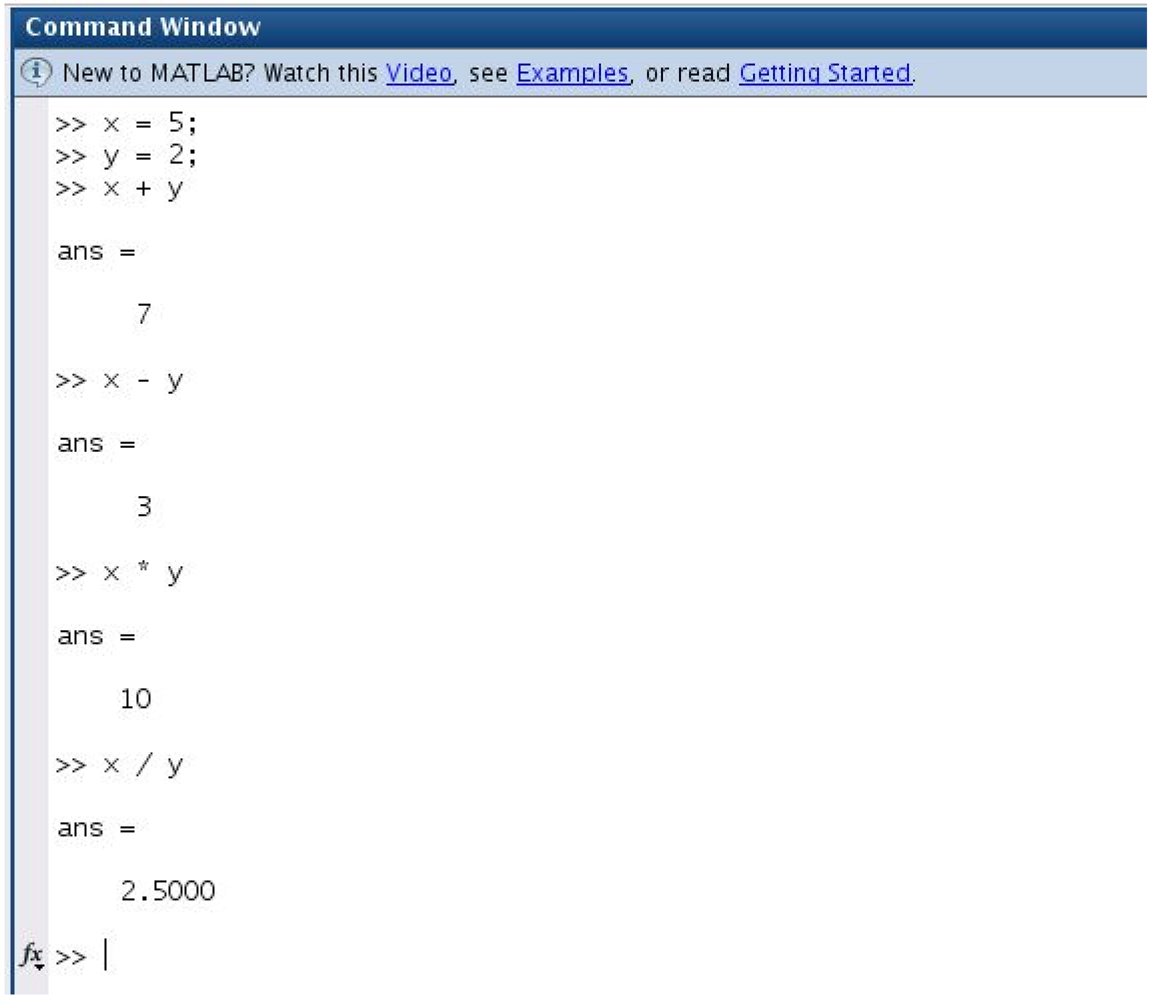


New to MATLAB? Watch this Video, see Examples, or read Getting Started.

```
>> x = 5

x =

     5

>> whos('x')
  Name      Size            Bytes  Class     Attributes

  x         1x1                 8  double              

>> x = 'ciao'

x =

ciao

>> whos('x')
  Name      Size            Bytes  Class    Attributes

  x         1x4                 8  char               

>> 
```

MATLAB: comandi base

Operazioni base:

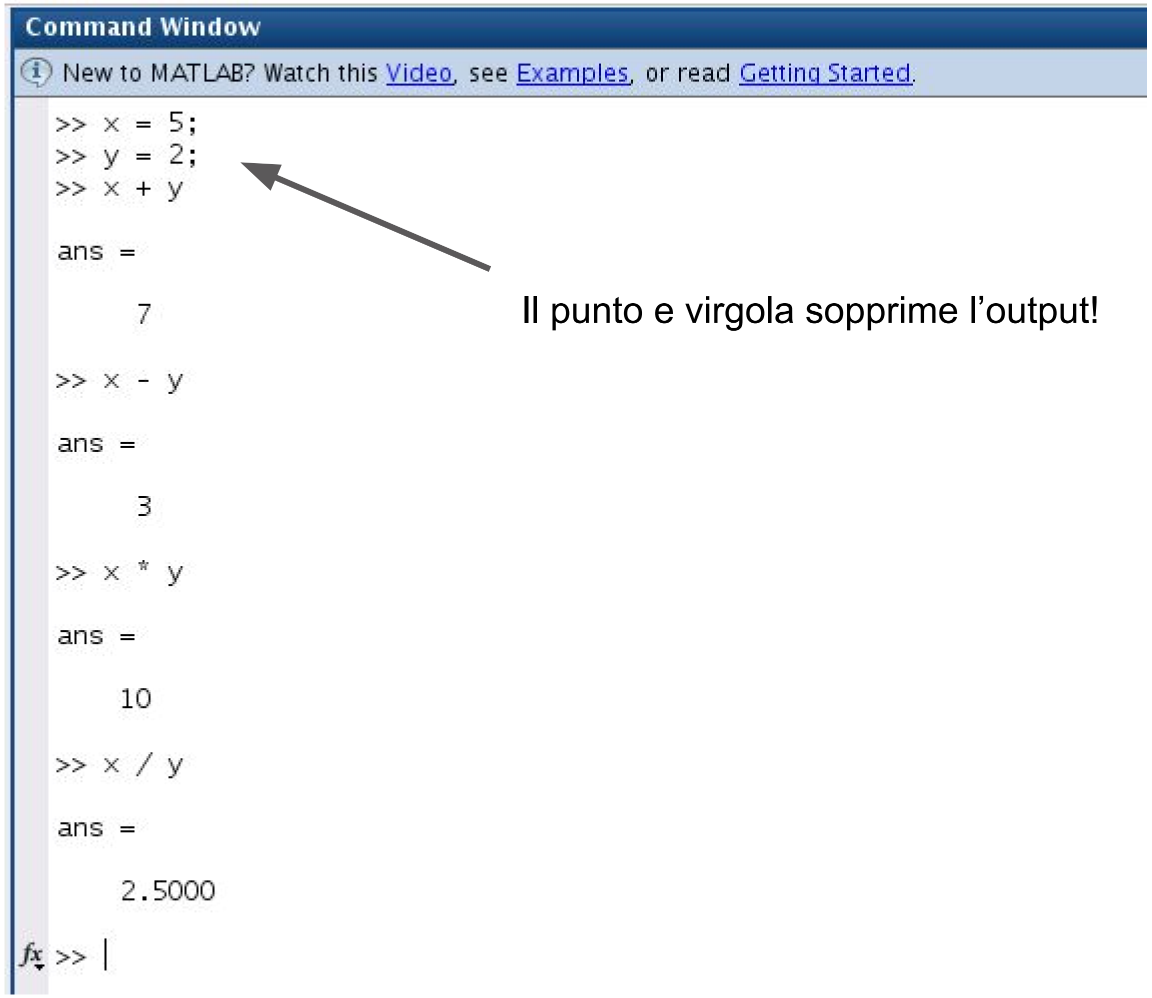

Command Window

New to MATLAB? Watch this Video, see Examples, or read Getting Started.

```
>> x = 5;
>> y = 2;
>> x + y

ans =

     7

>> x - y

ans =

     3

>> x * y

ans =

    10

>> x / y

ans =

    2.5000

>> |
```

MATLAB: comandi base

Operazioni base:


Command Window

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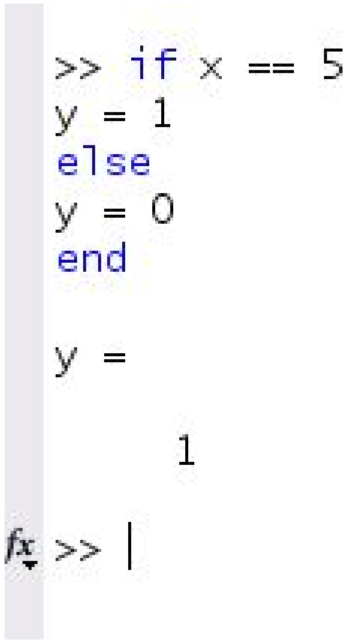
```
>> x = 5;
>> y = 2;
>> x + y

ans =

     7

>> x - y

ans =

     3

>> x * y

ans =

    10

>> x / y

ans =

    2.5000

>> 
```

Il punto e virgola sopprime l’output!

MATLAB: comandi base

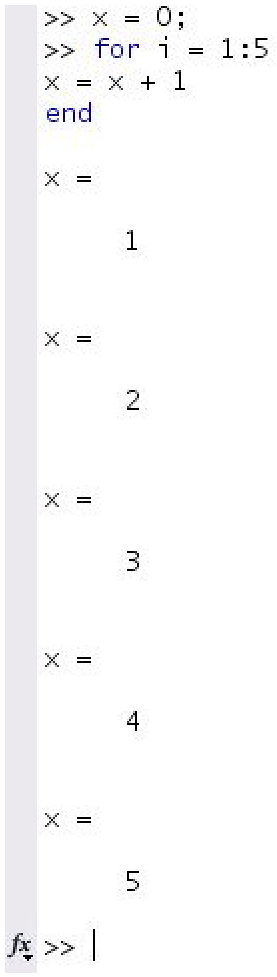
Costrutto “if”



```
>> if x == 5
y = 1
else
y = 0
end

y =

     1

>> |
```

MATLAB: comandi base

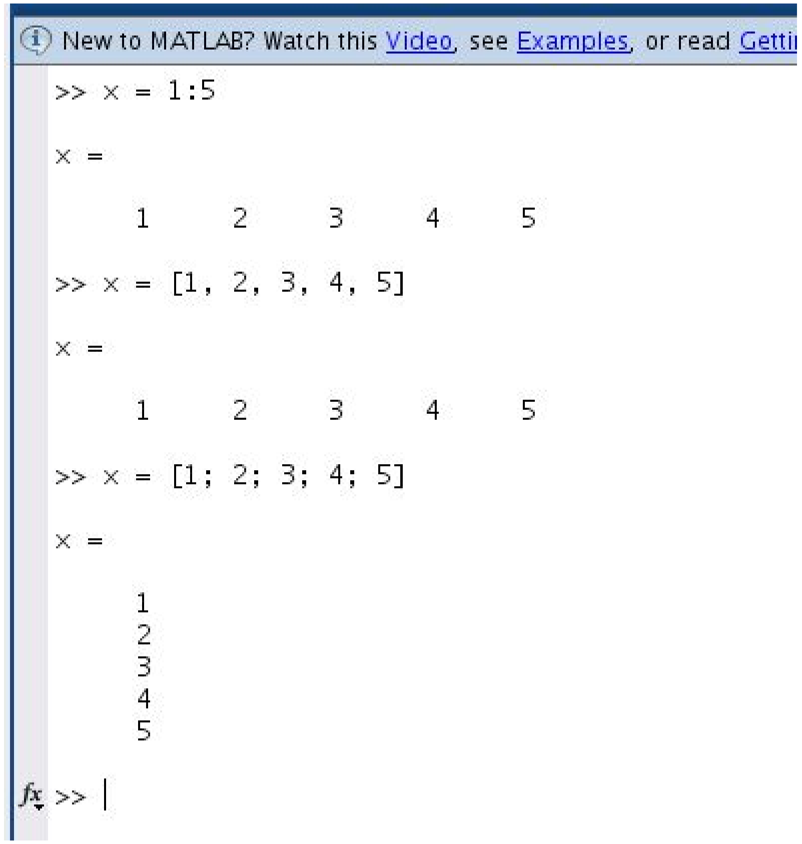
Costrutto “for”



```
>> x = 0;
>> for i = 1:5
x = x + 1
end

x =

     1


x =

     2


x =

     3


x =

     4


x =

     5

>> |
```

MATLAB: array

In MATLAB ci sono vari modi per dichiarare un array

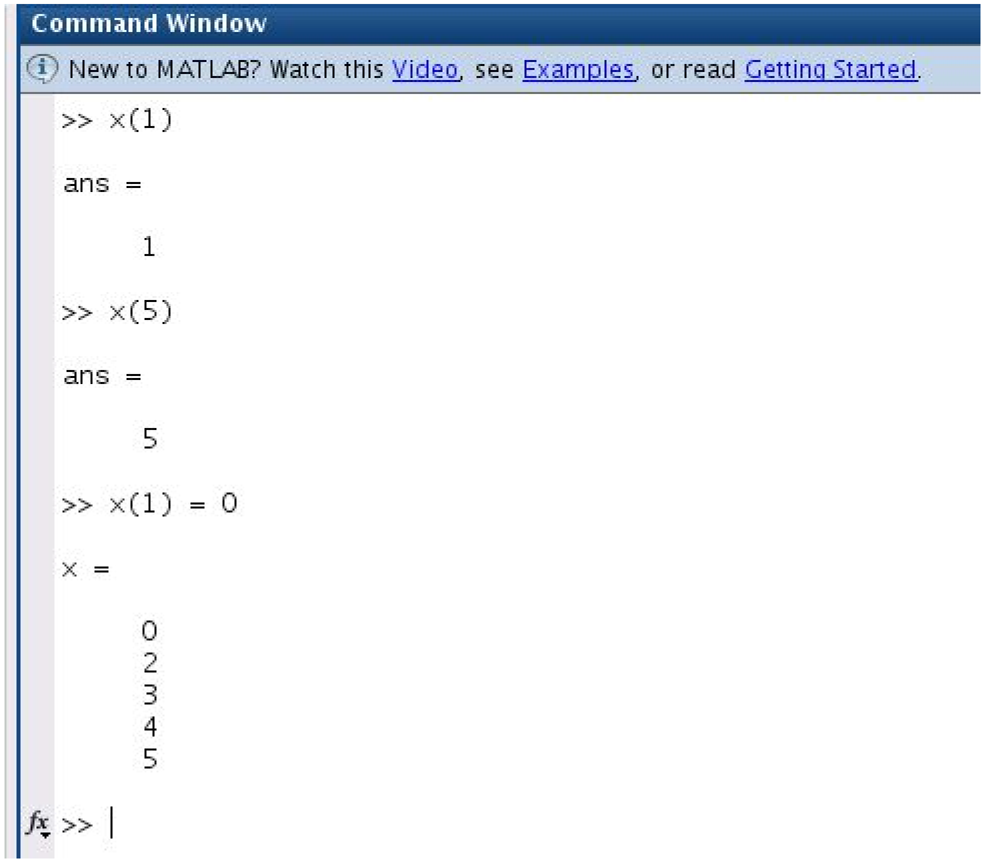


New to MATLAB? Watch this Video, see Examples, or read Getti

```
>> x = 1:5

x =

     1     2     3     4     5

>> x = [1, 2, 3, 4, 5]

x =

     1     2     3     4     5

>> x = [1; 2; 3; 4; 5]

x =

     1
     2
     3
     4
     5

>> |
```

MATLAB: array

- In MATLAB gli array partono da 1
- Per accedere si usano le parentesi tonde

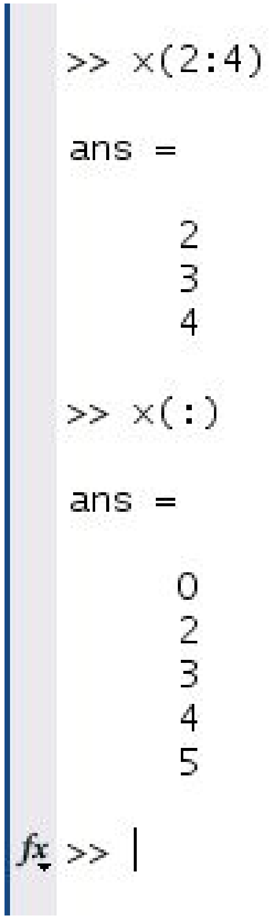


Command Window
New to MATLAB? Watch this Video, see Examples, or read Getting Started.

```
>> x(1)

ans =

     1

>> x(5)

ans =

     5

>> x(1) = 0

x =

     0
     2
     3
     4
     5

>> 
```

MATLAB: array

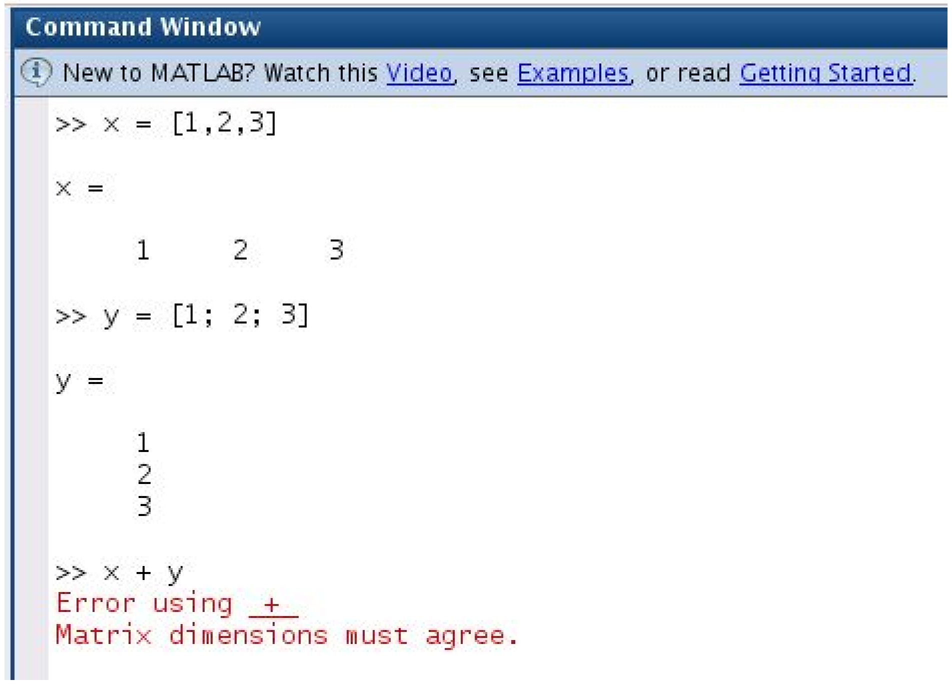
- L’operatore “:” permette di accedere a più valori



```
>> x(2:4)

ans =

     2
     3
     4

>> x(:)

ans =

     0
     2
     3
     4
     5

>>
```

MATLAB: array

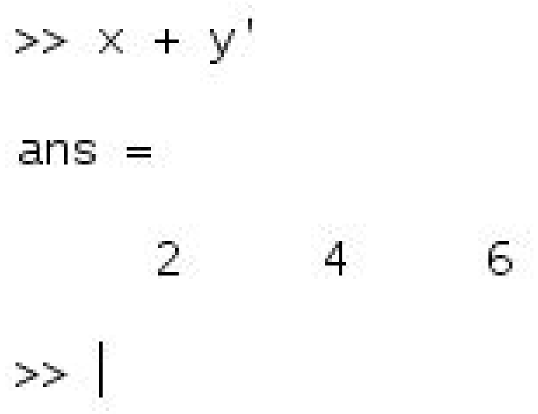
- Operazioni tra array (controllate la dimensione)


Command Window
New to MATLAB? Watch this Video, see Examples, or read Getting Started.

```
>> x = [1,2,3]

x =

     1     2     3

>> y = [1; 2; 3]

y =

     1
     2
     3

>> x + y
Error using  +
Matrix dimensions must agree.
```

MATLAB: array

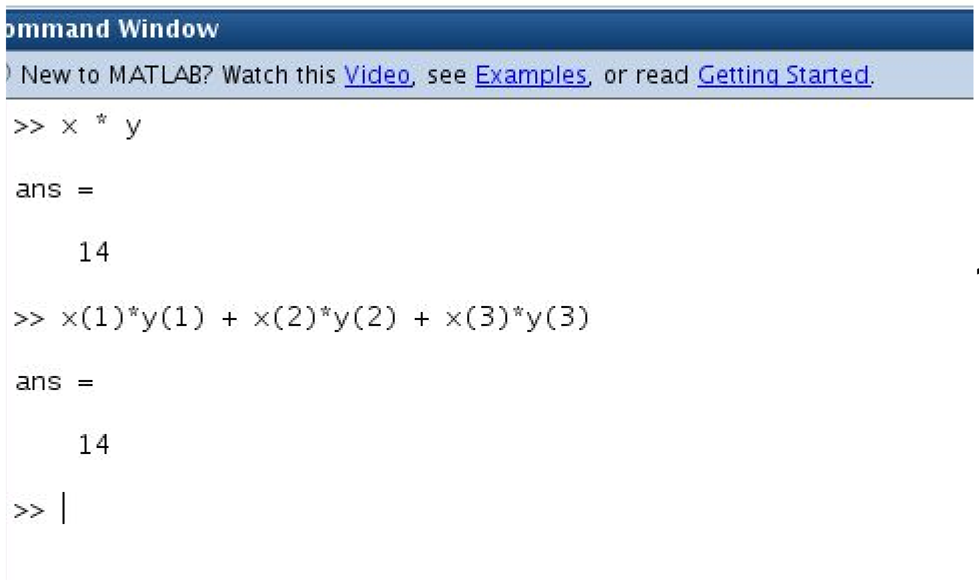
- L’apice “traspone” gli array (e le matrici)



```
>> x + y'

ans =

     2     4     6

>> |
```

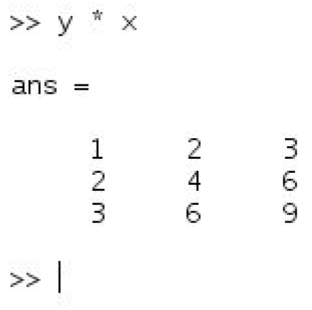
MATLAB: array

- L’operatore ‘*’ di default indica il prodotto vettoriale!


ommand Window
New to MATLAB? Watch this Video, see Examples, or read Getting Started.

```
>> x * y

ans =

    14

>> x(1)*y(1) + x(2)*y(2) + x(3)*y(3)

ans =

    14

>> |
```

1 X 3 * 3 X 1 = 1 X 1

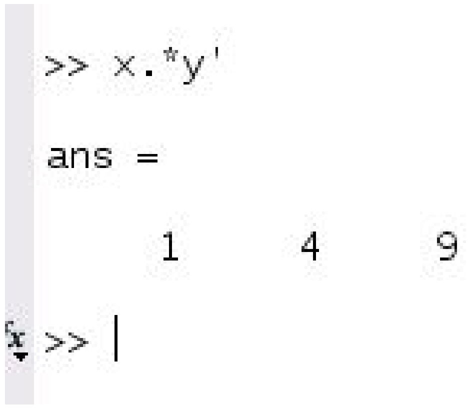


```
>> y * x

ans =

     1     2     3
     2     4     6
     3     6     9

>> |
```

3 X 1 * 1 X 3 = 3 X 3

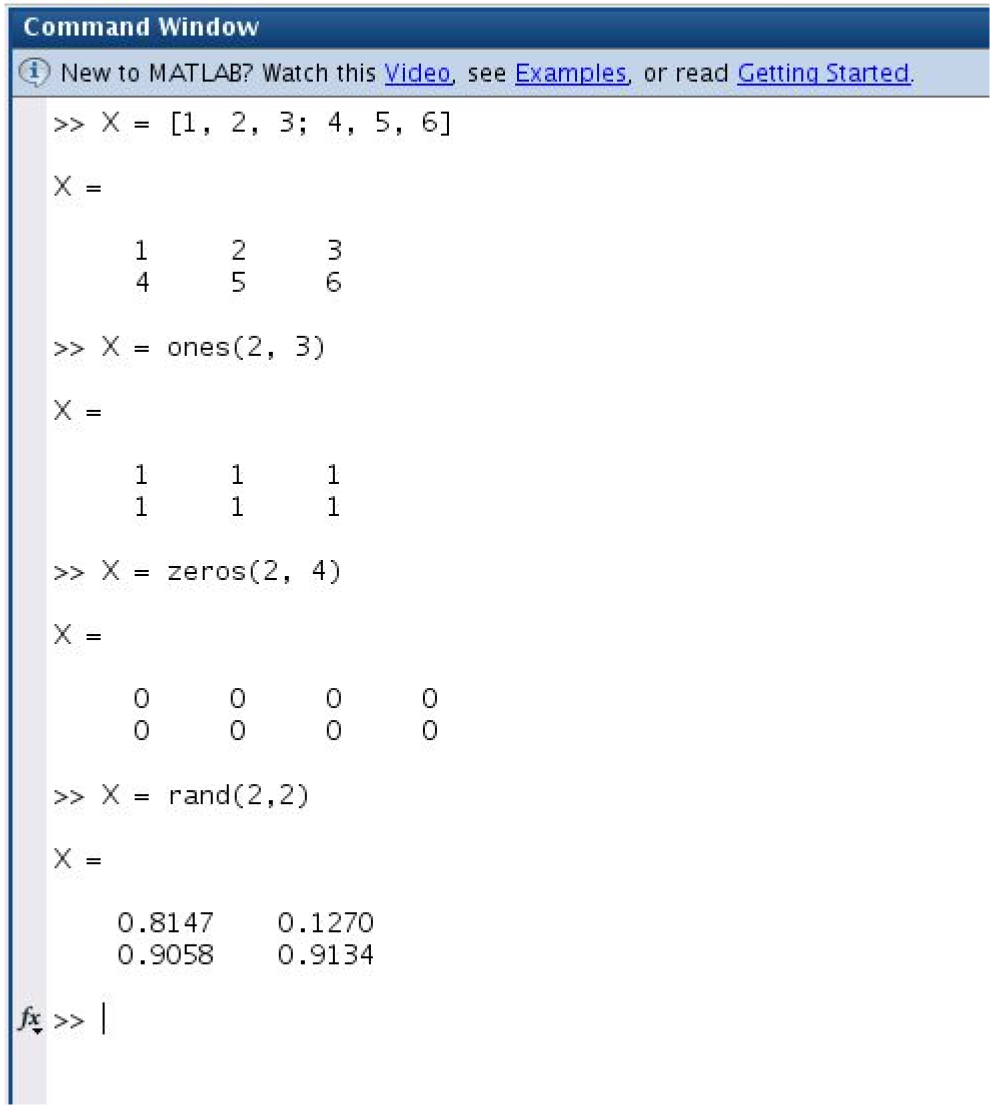
MATLAB: array

- Usate “ .* ” per il prodotto tra elementi



```
>> x.*y'

ans =

     1     4     9

>> 
```

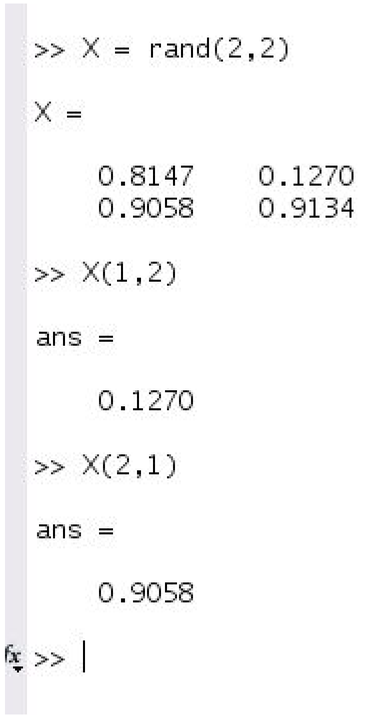
MATLAB: matrici


Command Window
New to MATLAB? Watch this Video, see Examples, or read Getting Started.

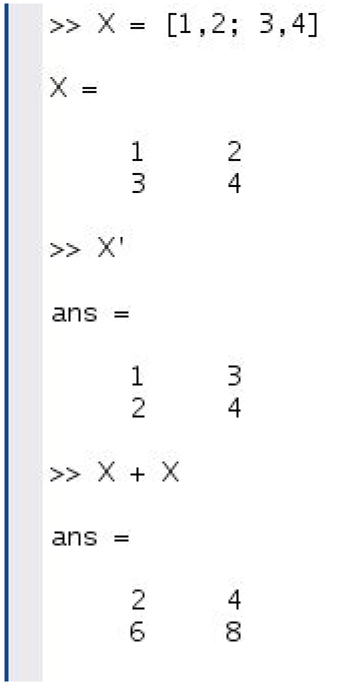
```
>> X = [1, 2, 3; 4, 5, 6]

X =

     1     2     3
     4     5     6

>> X = ones(2, 3)

X =

     1     1     1
     1     1     1

>> X = zeros(2, 4)

X =

     0     0     0     0
     0     0     0     0

>> X = rand(2,2)

X =

    0.8147    0.1270
    0.9058    0.9134

>> 
```

MATLAB: matrici

- Per MATLAB le matrici funzionano esattamente come gli array
- Di fatto gli array sono matrici 1XN (o NX1)



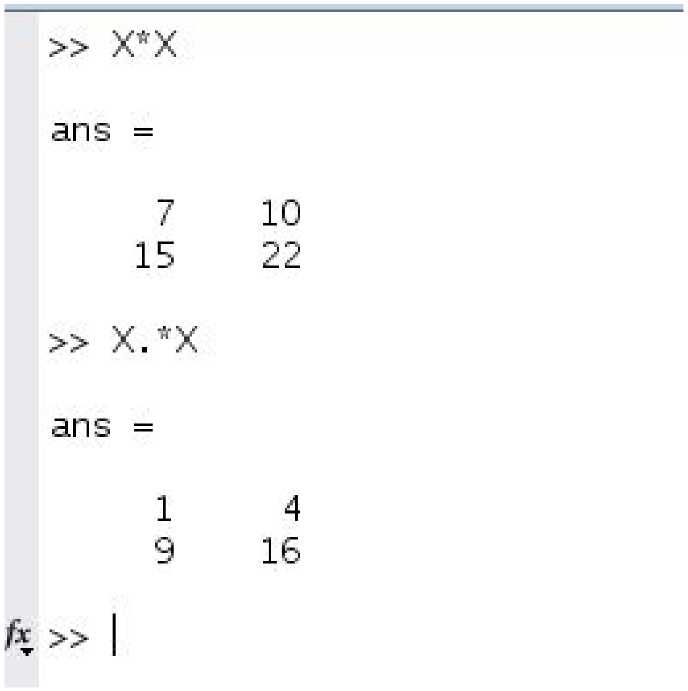
```
>> X = rand(2,2)

X =

    0.8147    0.1270
    0.9058    0.9134

>> X(1,2)

ans =

    0.1270

>> X(2,1)

ans =

    0.9058

>> |
```



```
>> X = [1,2; 3,4]

X =

     1     2
     3     4

>> X'

ans =

     1     3
     2     4

>> X + X

ans =

     2     4
     6     8
```

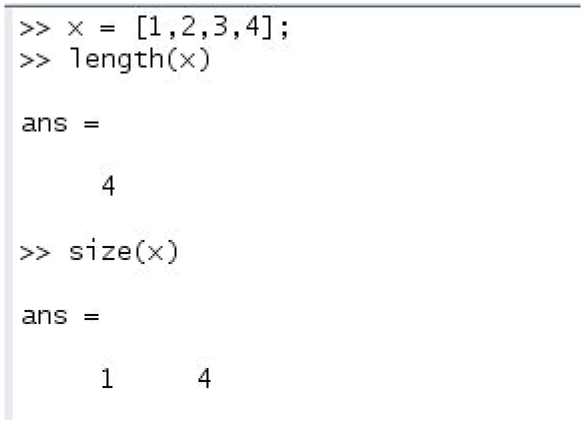
MATLAB: matrici

Vale sempre la regola del prodotto: l’operatore “ * “ indica il prodotto di matrici.

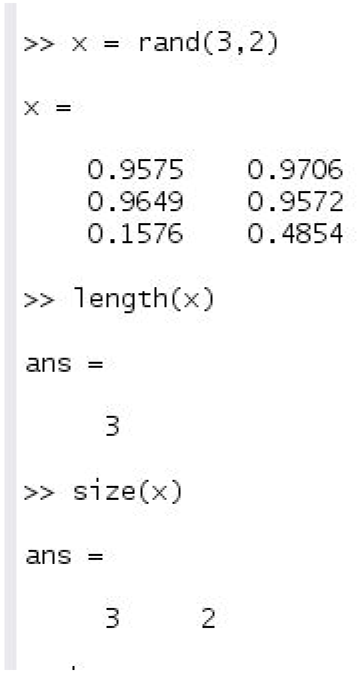


```
>> X*X

ans =

     7    10
    15    22

>> X.*X

ans =

     1     4
     9    16

>> |
```

MATLAB: comandi utili



```
>> x = [1,2,3,4];
>> length(x)

ans =

     4

>> size(x)

ans =

     1     4
```

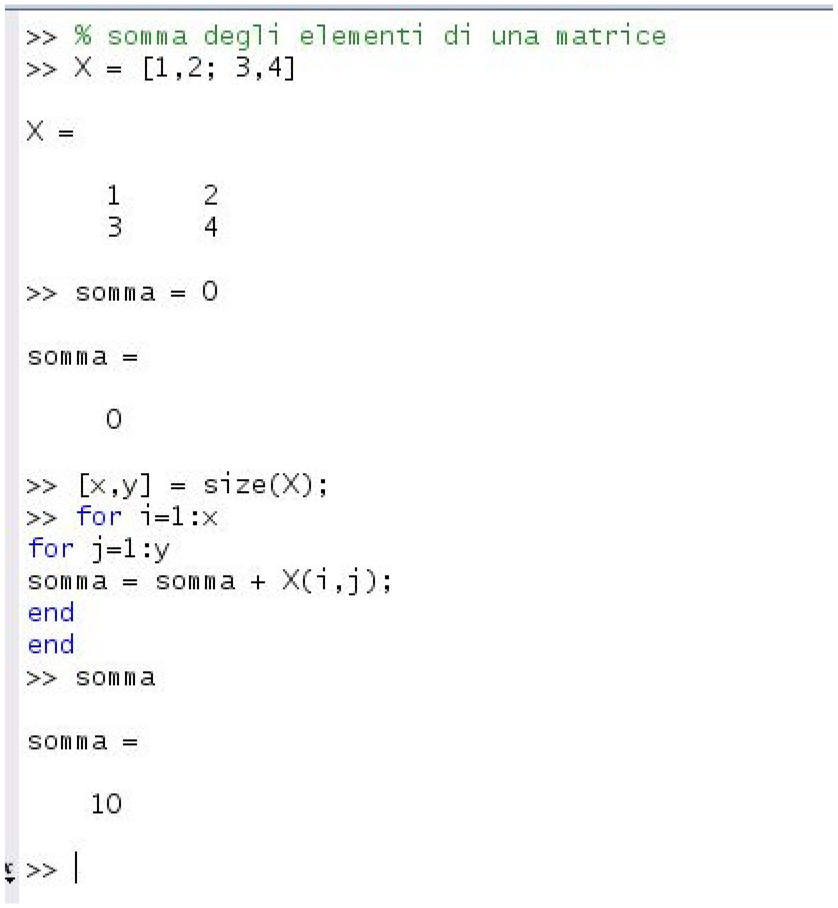


```
>> x = rand(3,2)

x =

    0.9575    0.9706
    0.9649    0.9572
    0.1576    0.4854

>> length(x)

ans =

     3

>> size(x)

ans =

     3     2
```

- il comando "*length*" ritorna la lunghezza di un vettore o il numero di righe di una matrice

- Il comando "*size*" ritorna il numero di righe e colonne

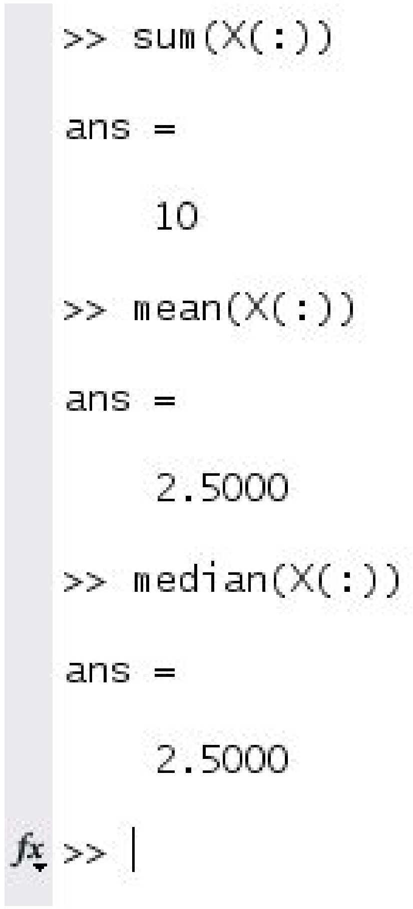
MATLAB: comandi utili



```
>> % somma degli elementi di una matrice
>> X = [1,2; 3,4]

X =

     1     2
     3     4

>> somma = 0

somma =

     0

>> [x,y] = size(X);
>> for i=1:x
for j=1:y
somma = somma + X(i,j);
end
end
>> somma

somma =

    10

>> |
```

MATLAB: comandi utili

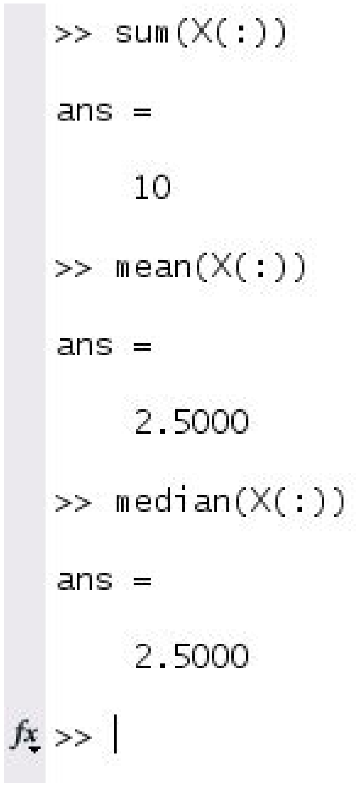
MATLAB ha già implementato praticamente tutte le funzioni matematiche



```
>> sum(X(:))

ans =

    10

>> mean(X(:))

ans =

    2.5000

>> median(X(:))

ans =

    2.5000

>> |
```

MATLAB: comandi utili

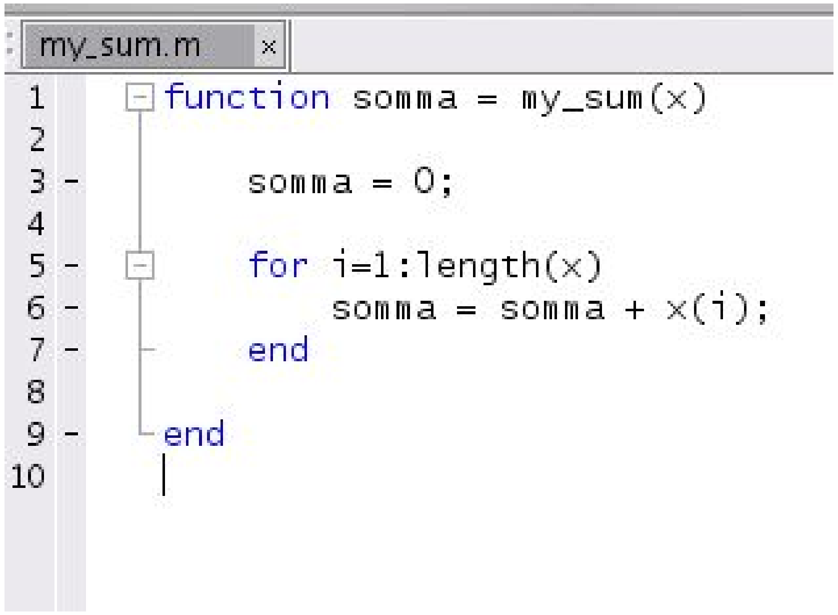
MATLAB ha già implementato praticamente tutte le funzioni matematiche



```
>> sum(X(:))

ans =

    10

>> mean(X(:))

ans =

    2.5000

>> median(X(:))

ans =

    2.5000

>> |
```

MATLAB: funzioni

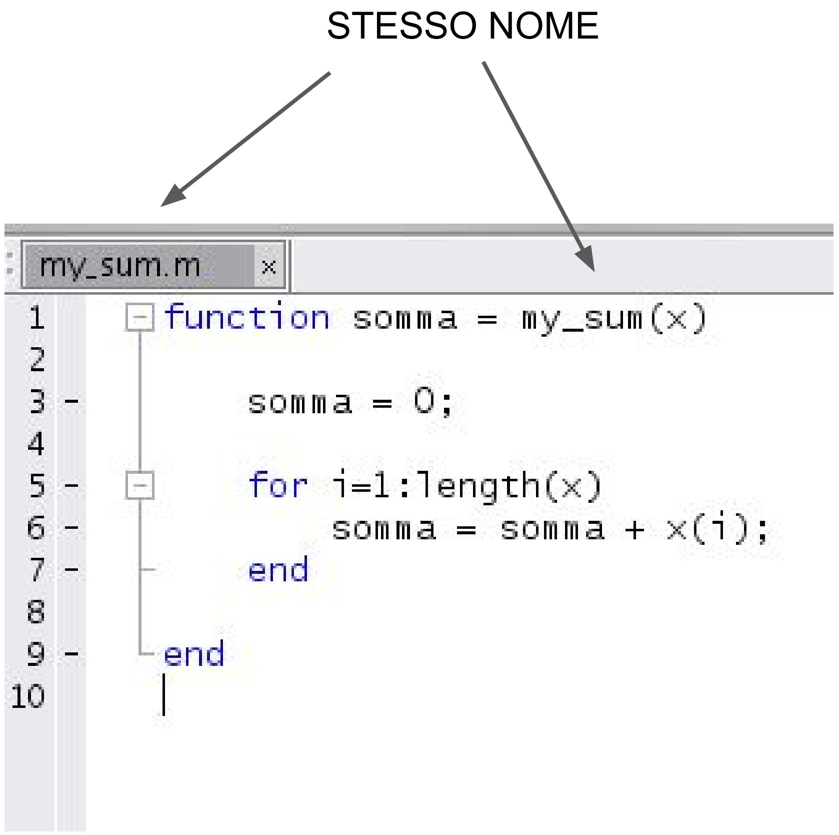
In MATLAB possiamo definire le nostre funzioni in file con l’estensione **.m**



```
function somma = my_sum(x)

    somma = 0;

    for i=1:length(x)
        somma = somma + x(i);
    end

end
```

MATLAB: funzioni

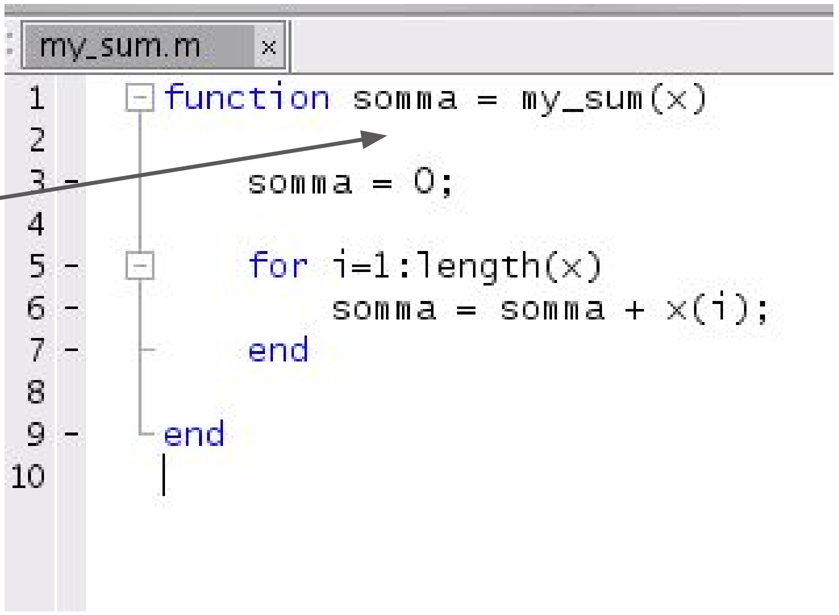
In MATLAB possiamo definire le nostre funzioni in file con l’estensione **.m**



```
function somma = my_sum(x)

    somma = 0;

    for i=1:length(x)
        somma = somma + x(i);
    end

end
```

MATLAB: funzioni

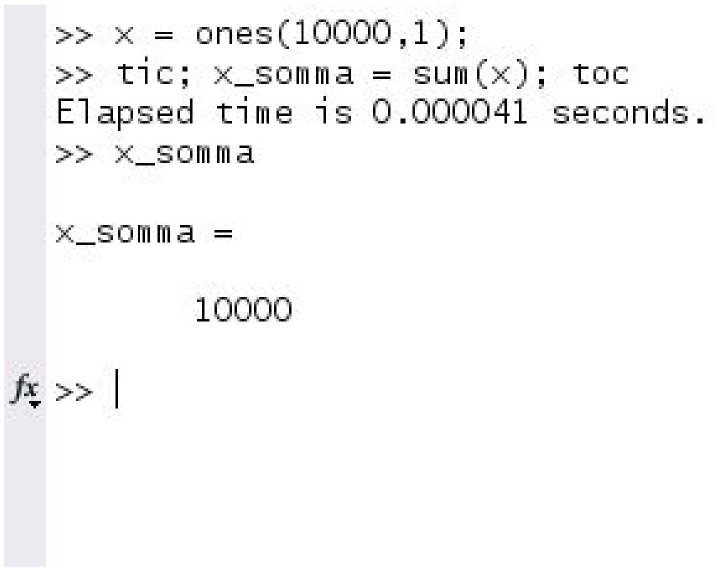
In MATLAB possiamo definire le nostre funzioni in file con l’estensione **.m**



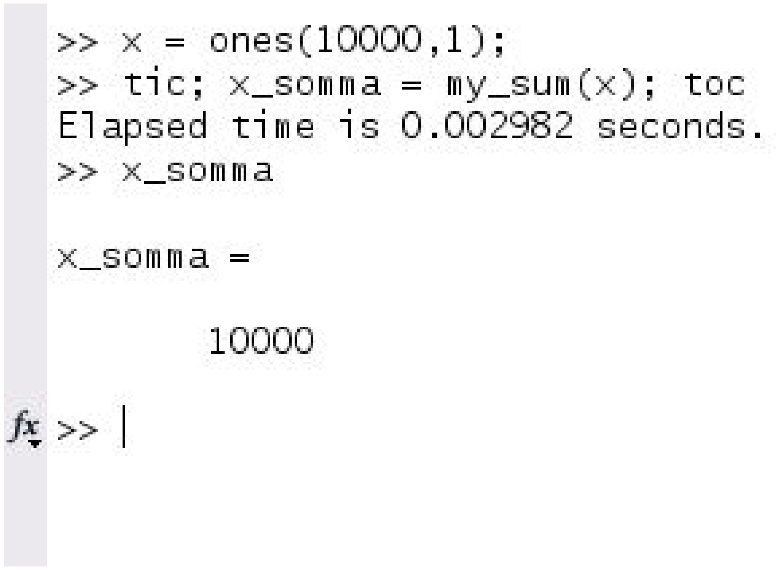
```
function somma = my_sum(x)

        somma = 0;

        for i=1:length(x)
            somma = somma + x(i);
        end

end
```

MATLAB: attenzione

MATLAB è super-ottimizzato per le operazioni matriciali, non usiamo i clicli se non strettamente necessario!



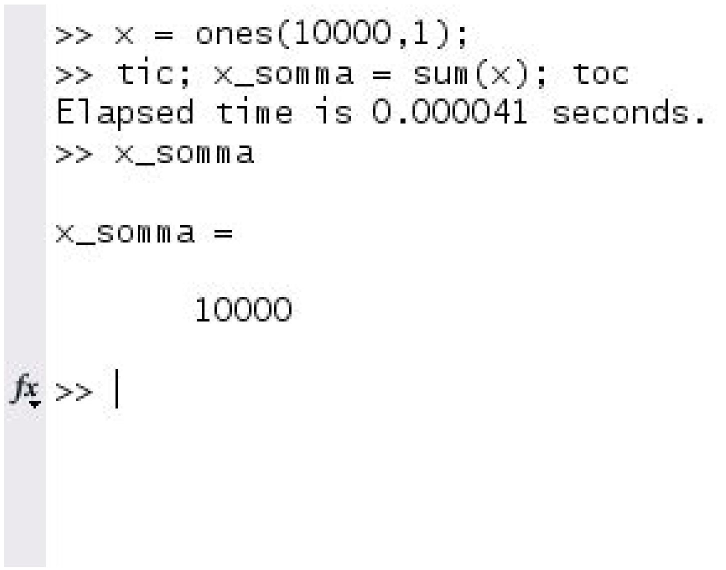
```
>> x = ones(10000,1);
>> tic; x_somma = sum(x); toc
Elapsed time is 0.000041 seconds.
>> x_somma

x_somma =

       10000

>> |
```



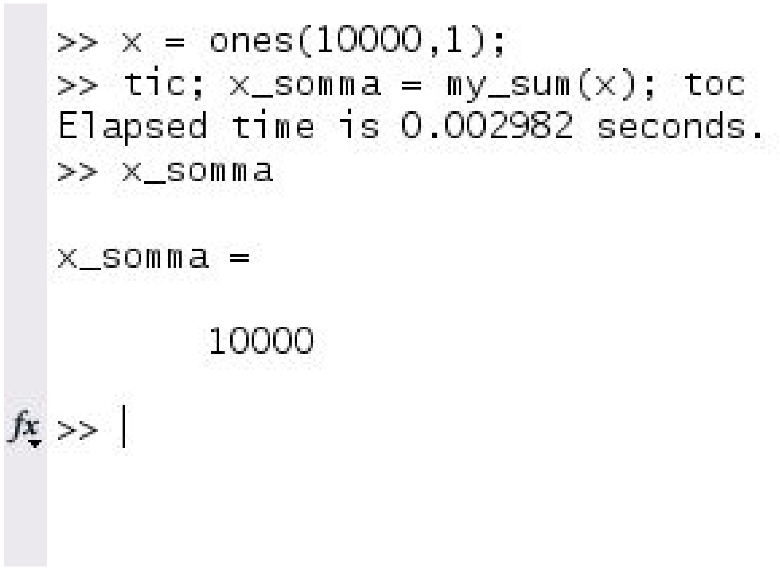
```
>> x = ones(10000,1);
>> tic; x_somma = my_sum(x); toc
Elapsed time is 0.002982 seconds.
>> x_somma

x_somma =

       10000

>> |
```

MATLAB: attenzione

MATLAB è super-ottimizzato per le operazioni matriciali, non usiamo i clicli se non strettamente necessario!



```
>> x = ones(10000,1);
>> tic; x_somma = sum(x); toc
Elapsed time is 0.000041 seconds.
>> x_somma

x_somma =

       10000

>> 
```

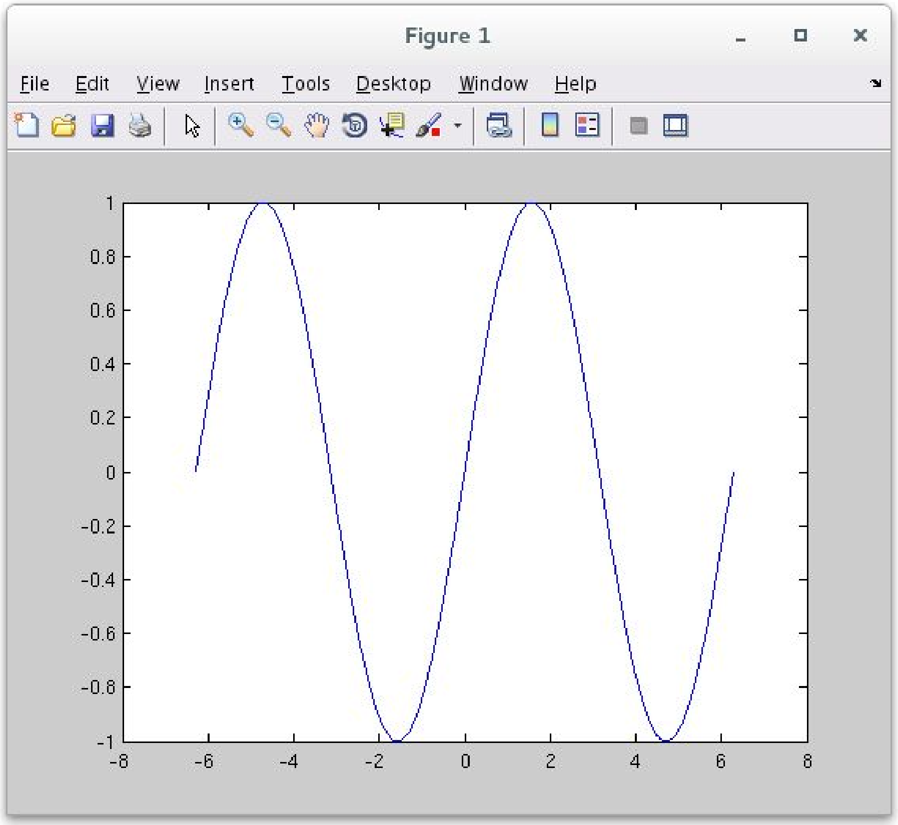


```
>> x = ones(10000,1);
>> tic; x_somma = my_sum(x); toc
Elapsed time is 0.002982 seconds.
>> x_somma

x_somma =

       10000

>> 
```

La funzione **sum** di MATLAB è 72 volte più veloce di **my_sum**

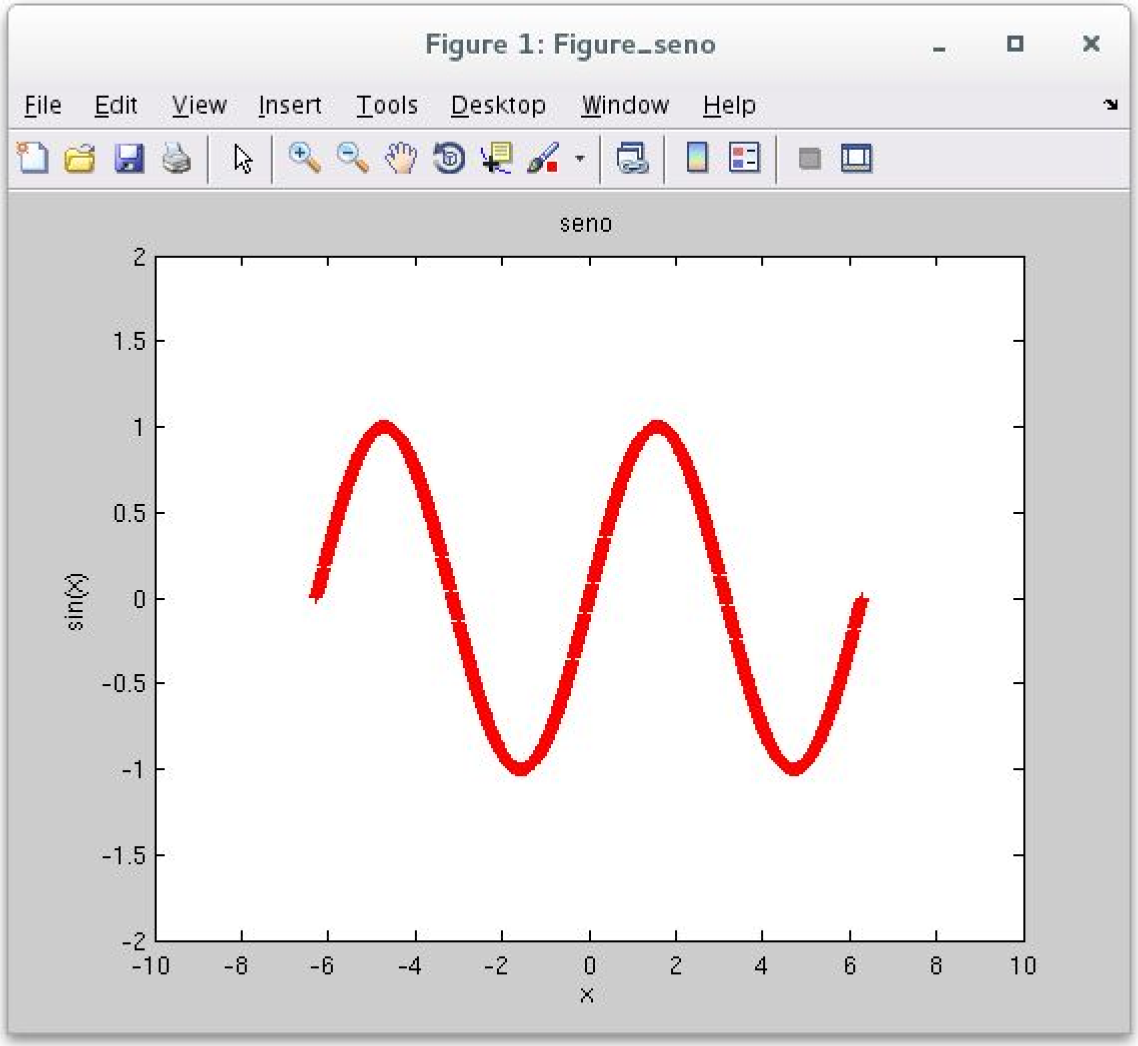
MATLAB: plot

```
>> x = linspace(-2*pi,2*pi,1000);
>> y = sin(x);
>> plot(x,y)
>>
```



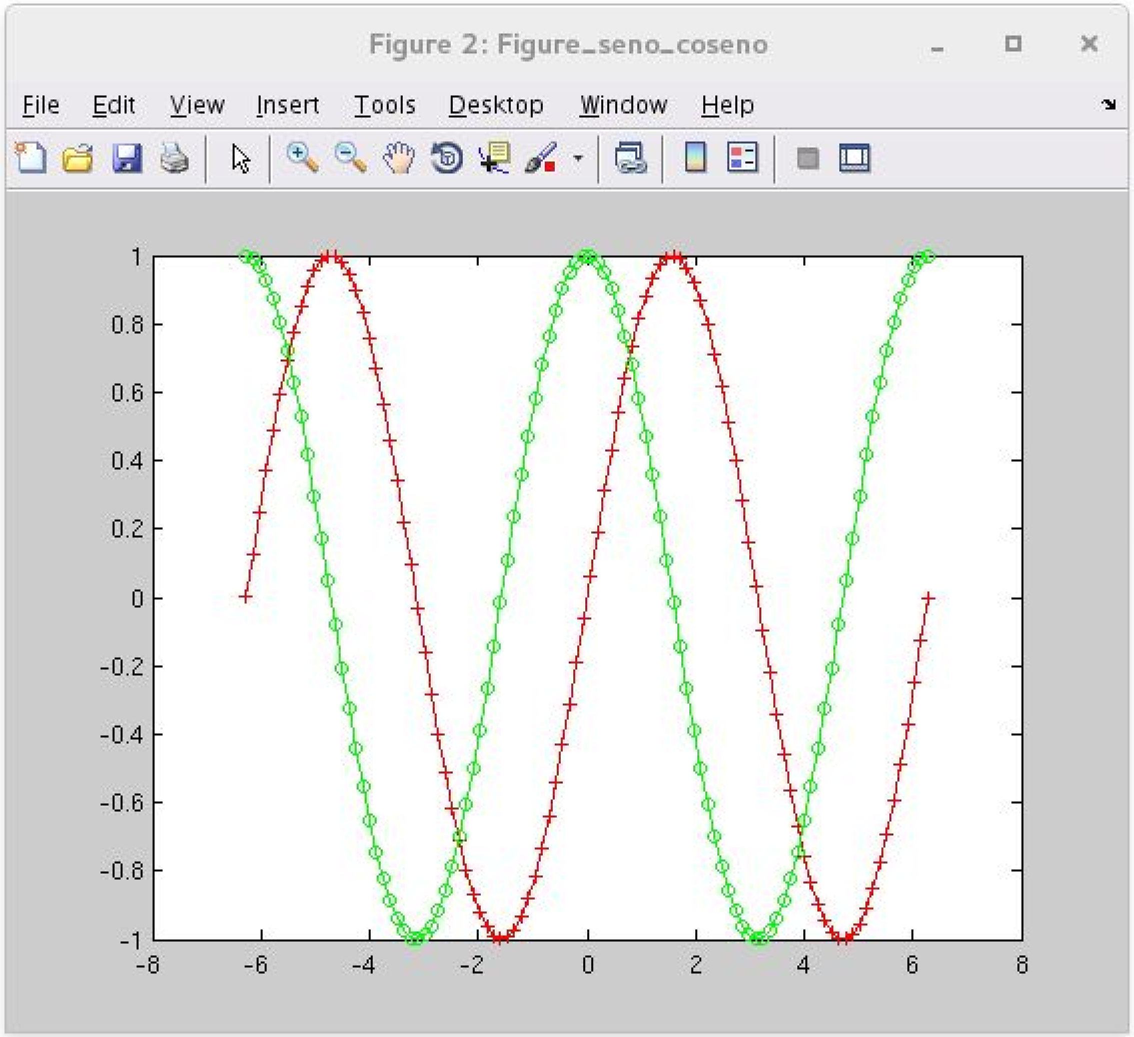
MATLAB: plot

```
>> x = linspace(-2*pi,2*pi,1000);
>> y = sin(x);
>> figure('Name','Figure_seno');
>> plot(x,y,'r+-')
>> xlabel('x');
>> ylabel('sin(x)');
>> title('seno');
>> axis([-10,10,-2,2]);
>>
```



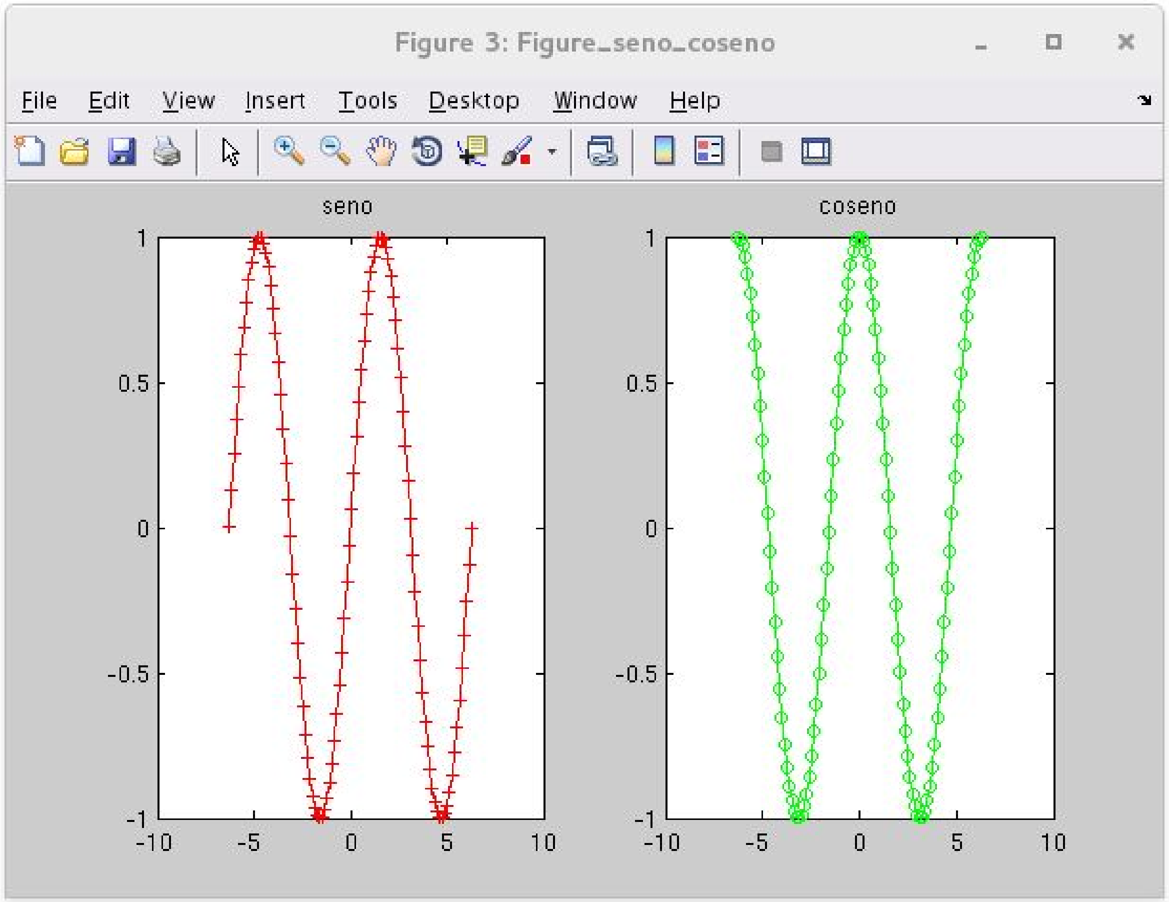
MATLAB: multiple plots: “hold on”

```
>> x = linspace(-2*pi,2*pi,100);
>> y = sin(x);
>> z = cos(x);
>> figure('Name','Figure_seno_coseno');
>> plot(x,y,'r+-')
>> hold on;
>> plot(x,z,'go-')
>> hold off;
>> |
```



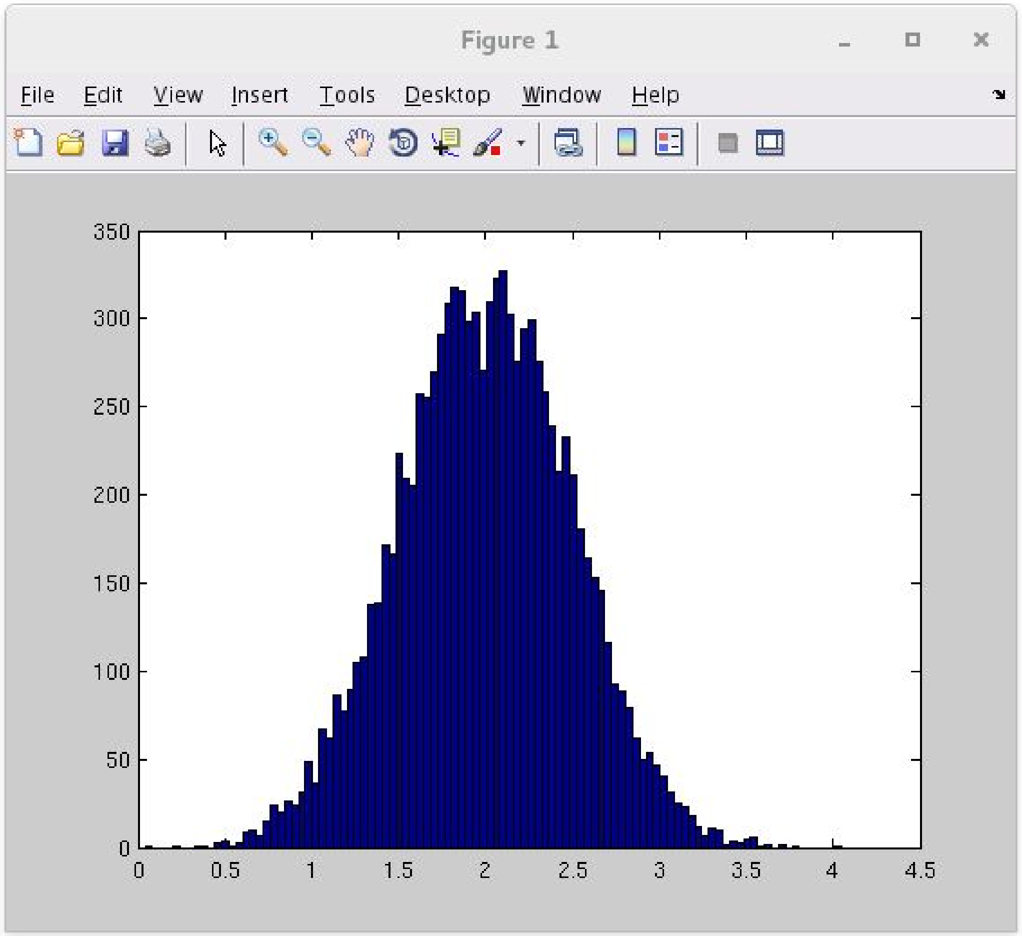
MATLAB: multiple plots: “subplot”

```
>> x = linspace(-2*pi,2*pi,100);
>> y = sin(x);
>> z = cos(x);
>> figure('Name','Figure_seno_coseno');
>> subplot(1,2,1)
>> plot(x,y,'r+-')
>> title('seno')
>> subplot(1,2,2)
>> plot(x,z,'go-')
>> title('coseno')
>> |
```



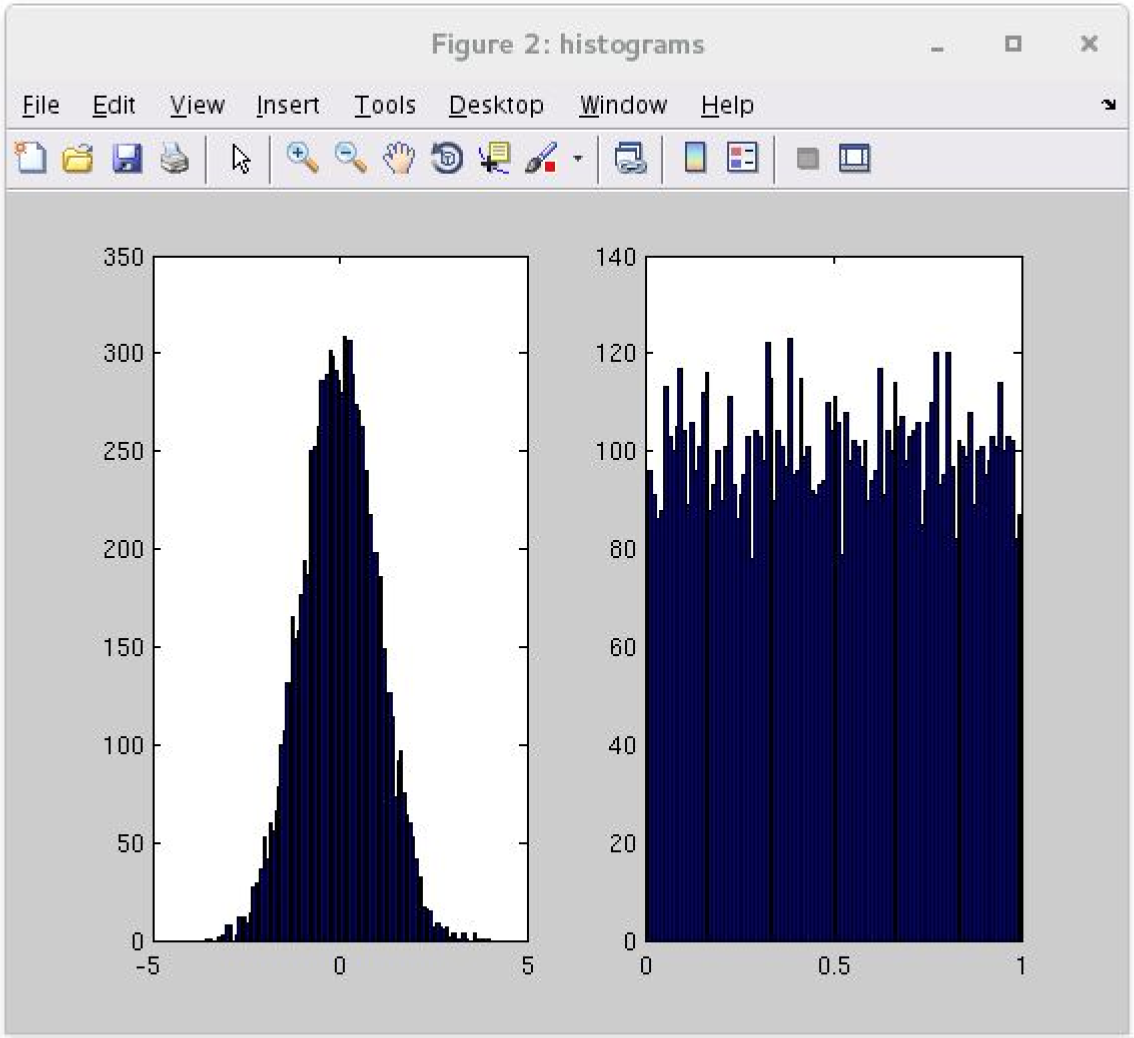
MATLAB: histograms

```
>> x = randn(1,10000);
>> hist(x,100)
>> x = randn(1,10000)*0.5 + 2;
>> hist(x,100)
>> |
```



MATLAB: histograms

```
>> figure('Name','histograms');
>> subplot(1,2,1)
>> x = randn(1,10000);
>> hist(x,100)
>> subplot(1,2,2)
>> x = rand(1,10000);
>> hist(x,100)
>> |
```



LE IMMAGINI

MATLAB: le immagini

- MATLAB vede le immagini come matrici:
    - Immagini in bianco e nero (scala di grigi) come matrici NXM;
    - Immagini a colori come matrici NXMX3 (RGB);

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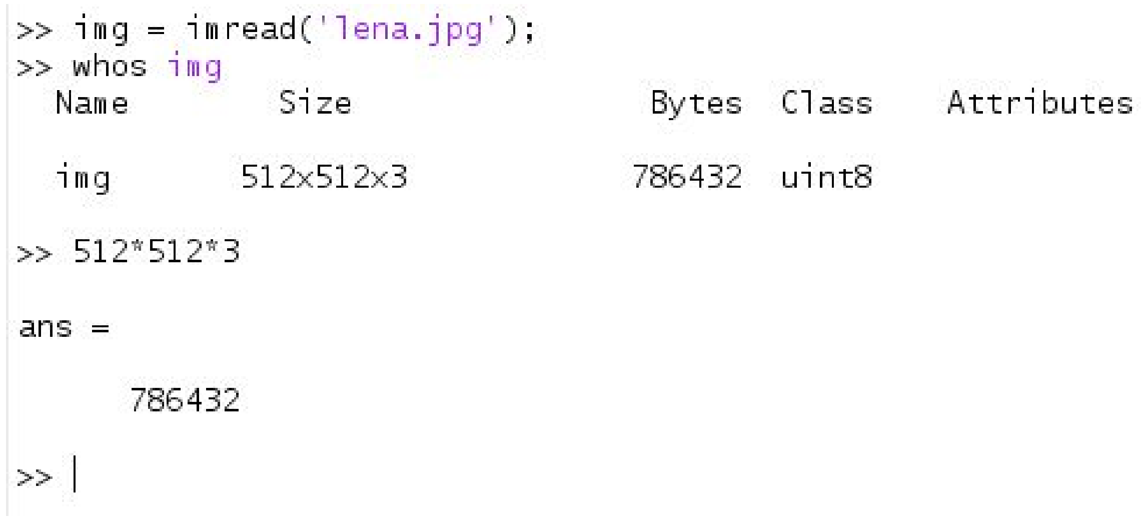
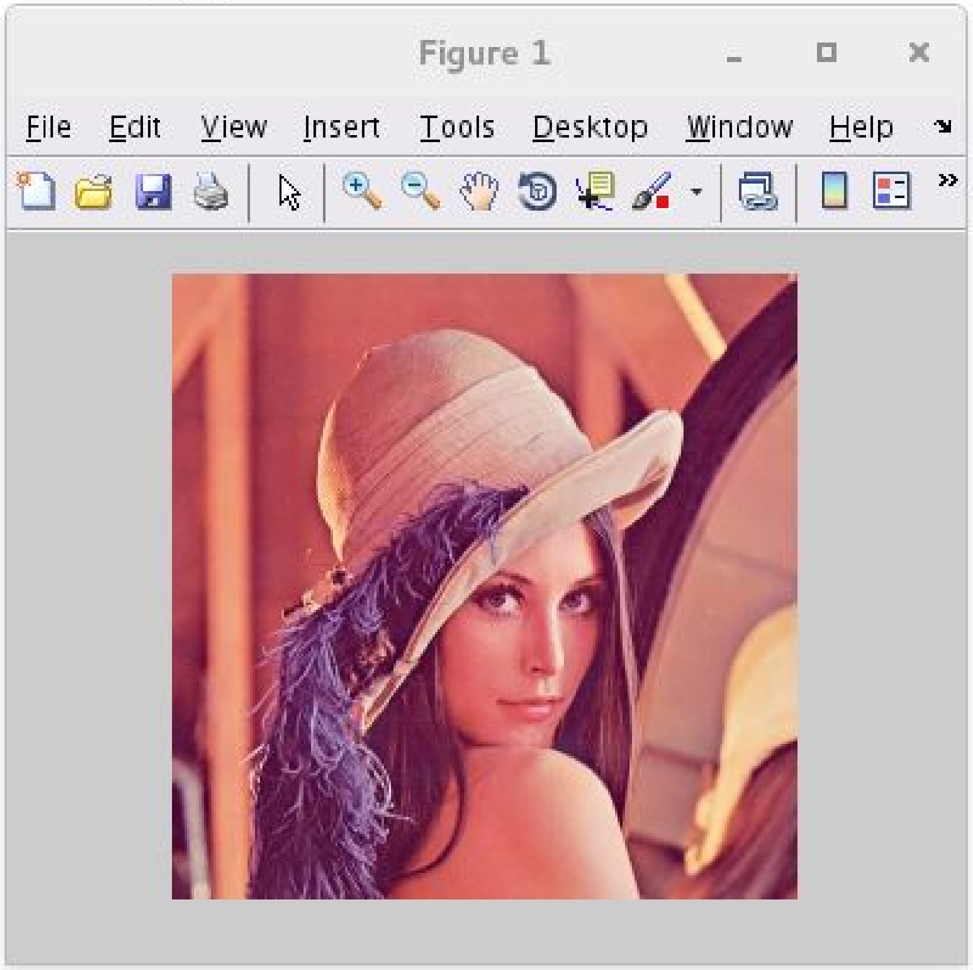


```
>> img = imread('lena.jpg');
>> whos img
  Name        Size                Bytes  Class    Attributes

  img       512x512x3            786432  uint8

>> 512*512*3

ans =

      786432

>> 
```

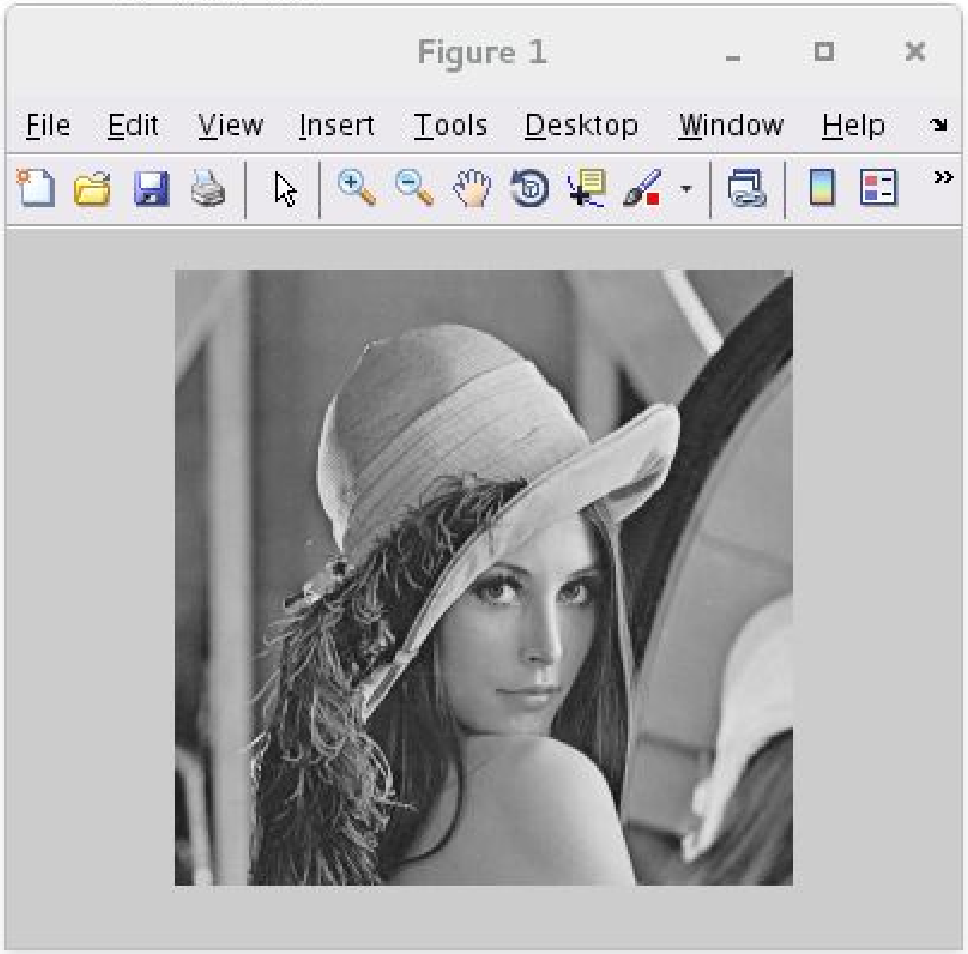
MATLAB: le immagini

```
>> imshow(img)
>>
```



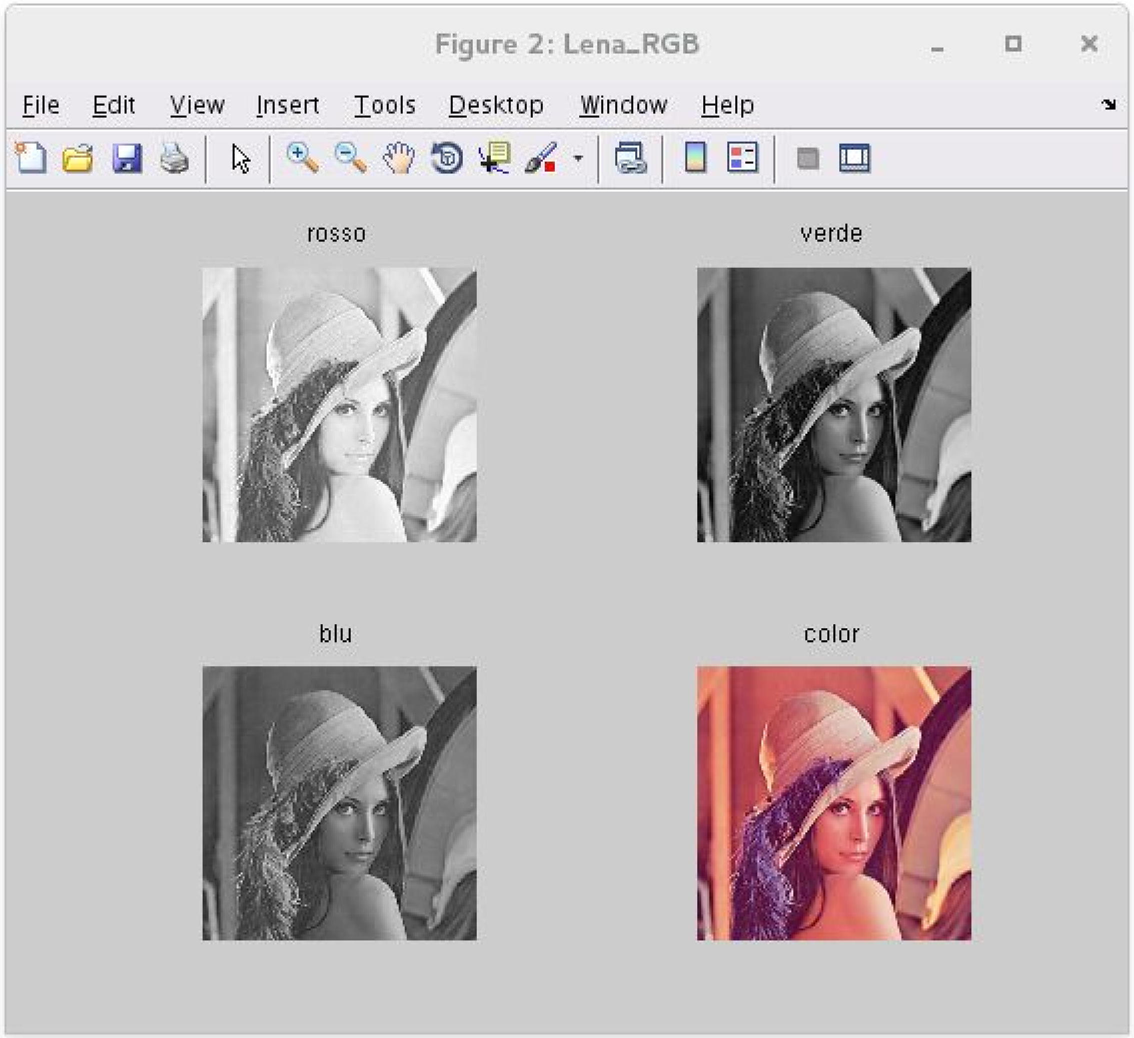
MATLAB: le immagini

```
>> img_gray = rgb2gray(img);
>> imshow(img_gray)
>>
```



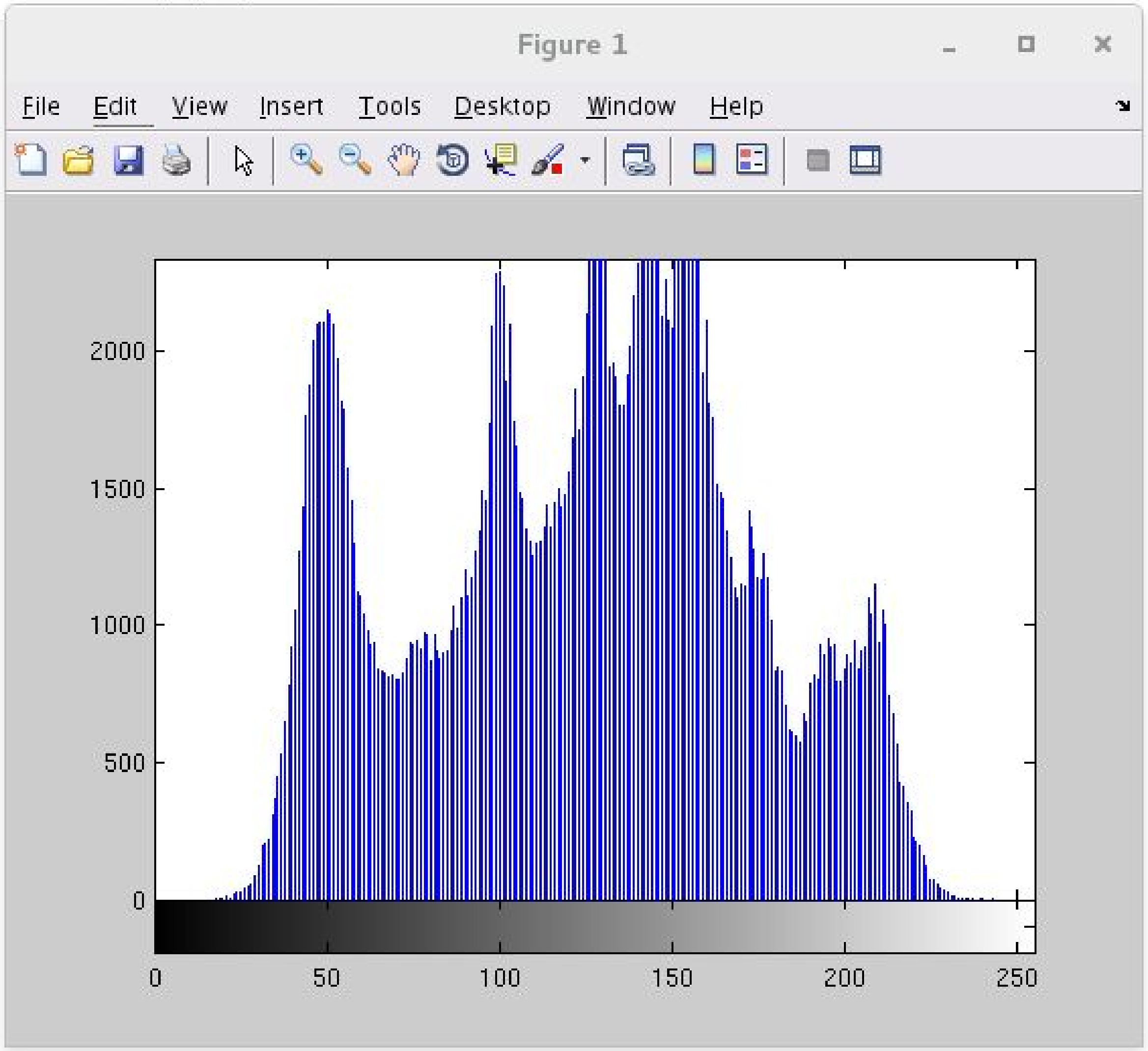
MATLAB: le immagini

```
rosso = img(:,:,1);
verde = img(:,:,2);
blu = img(:,:,3);
figure('Name','Lena_RGB');
subplot(2,2,1);
imshow(rosso);
title('rosso')
subplot(2,2,2);
imshow(verde);
title('verde');
subplot(2,2,3);
imshow(blu);
title('blu')
subplot(2,2,4);
imshow(img);
title('color')
```



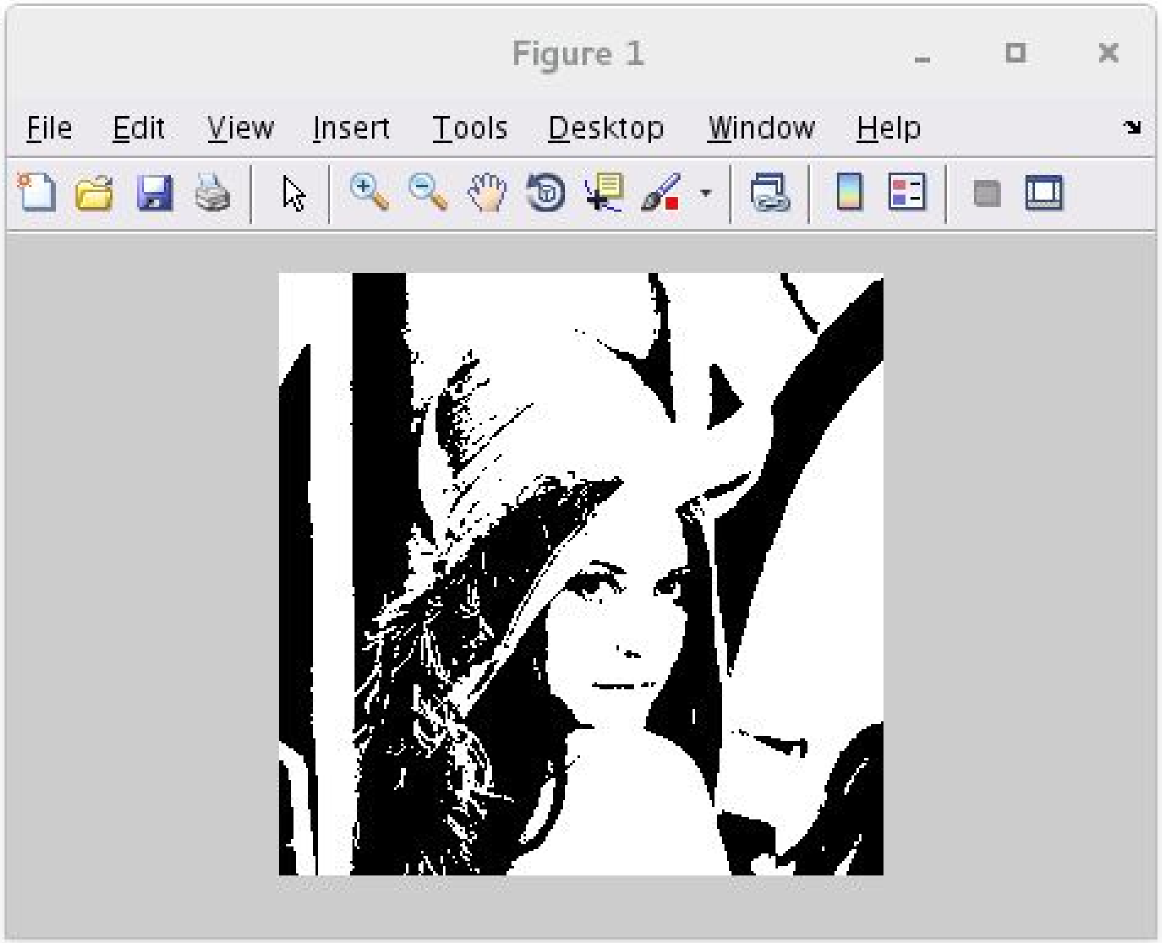
MATLAB: le immagini

```
>> imhist(img_gray,500)
>>
```



MATLAB: le immagini

```
>> img_bw = img_gray > 112;
>> imshow(img_bw)
>>
```



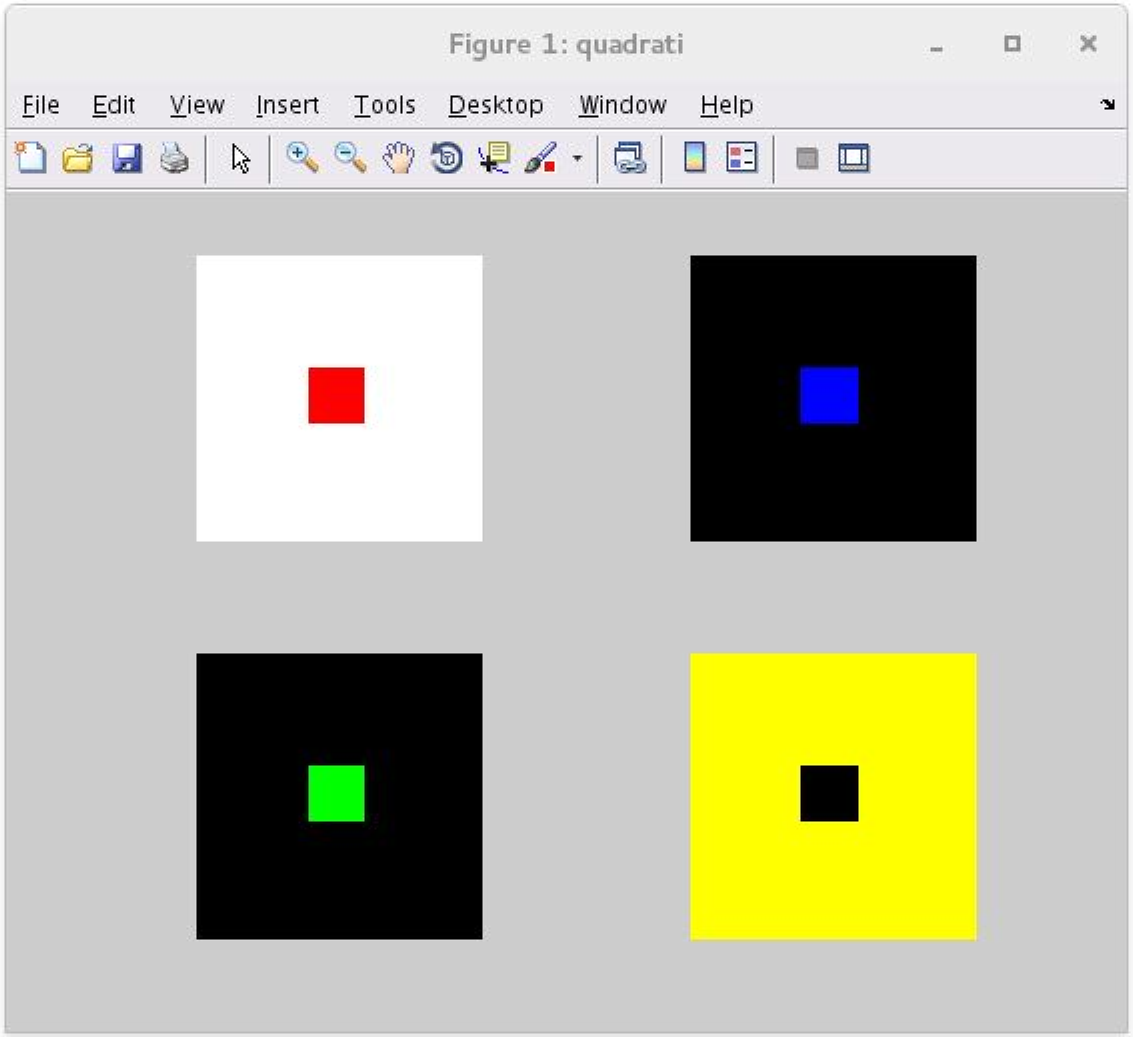
MATLAB: compiti per oggi

Disegnare in una figure 4 immagini 512X512

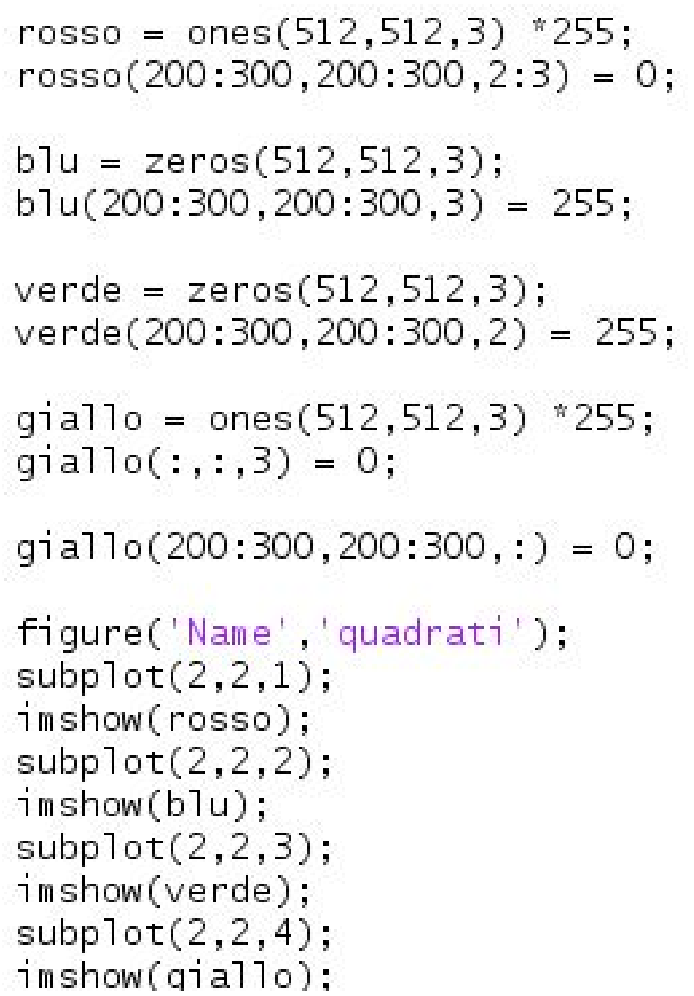
rappresentanti:

- Un quadrato rosso su sfondo bianco
- Un quadrato blu su sfondo nero
- Un quadrato verde su sfondo nero
- Un quadrato nero su sfondo giallo

MATLAB: compiti per oggi



MATLAB: compiti per oggi



```
rosso = ones(512,512,3) *255;
rosso(200:300,200:300,2:3) = 0;

blu = zeros(512,512,3);
blu(200:300,200:300,3) = 255;

verde = zeros(512,512,3);
verde(200:300,200:300,2) = 255;

giallo = ones(512,512,3) *255;
giallo(:,:,3) = 0;

giallo(200:300,200:300,:) = 0;

figure('Name','quadrati');
subplot(2,2,1);
imshow(rosso);
subplot(2,2,2);
imshow(blu);
subplot(2,2,3);
imshow(verde);
subplot(2,2,4);
imshow(giallo);
```