Introduction to MATLAB

5: Graphics with MATLAB

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Πανεπιστήμιο Κύπρου
Τμήμα Μαθηματικών
και Στατιστικής

plot

plot
title
xlabel
ylabel
legend

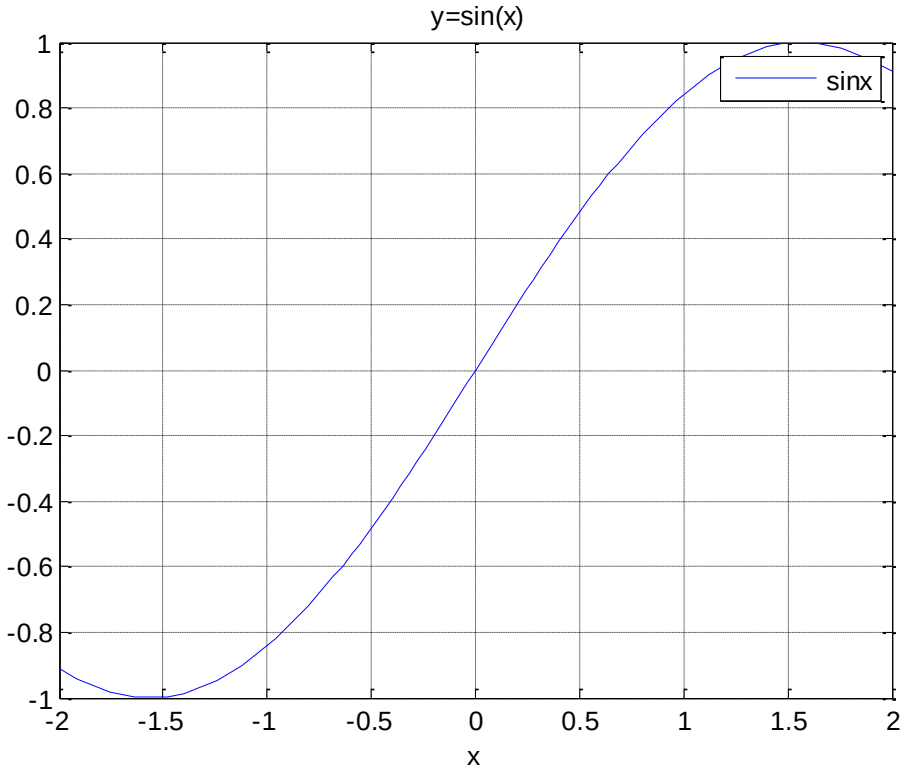
text
grid

figure
plotedit
hold on, hold off

axis

plot

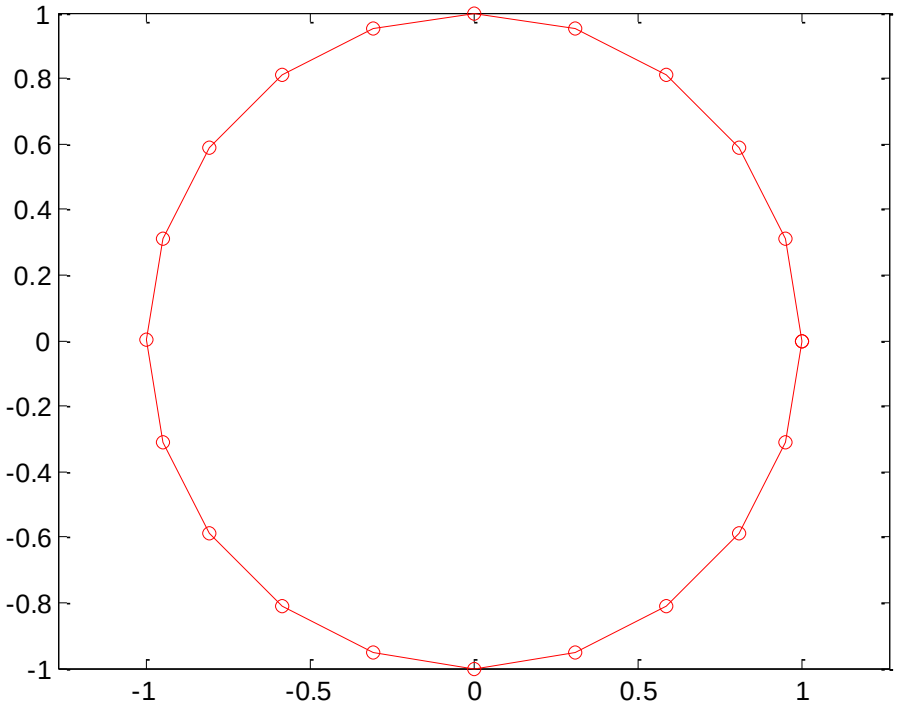
```
>> x=linspace(-2,2,101); plot(x, sin(x))
>> xlabel('x'), title('y=sin(x)')
>> grid
>> legend('sinx')
```



Much more options in the figure window!

Plot with complex functions

```
>> t=0:pi/10:2*pi;
>> plot(exp(i*t),‘r-o')
>> axis equal
```

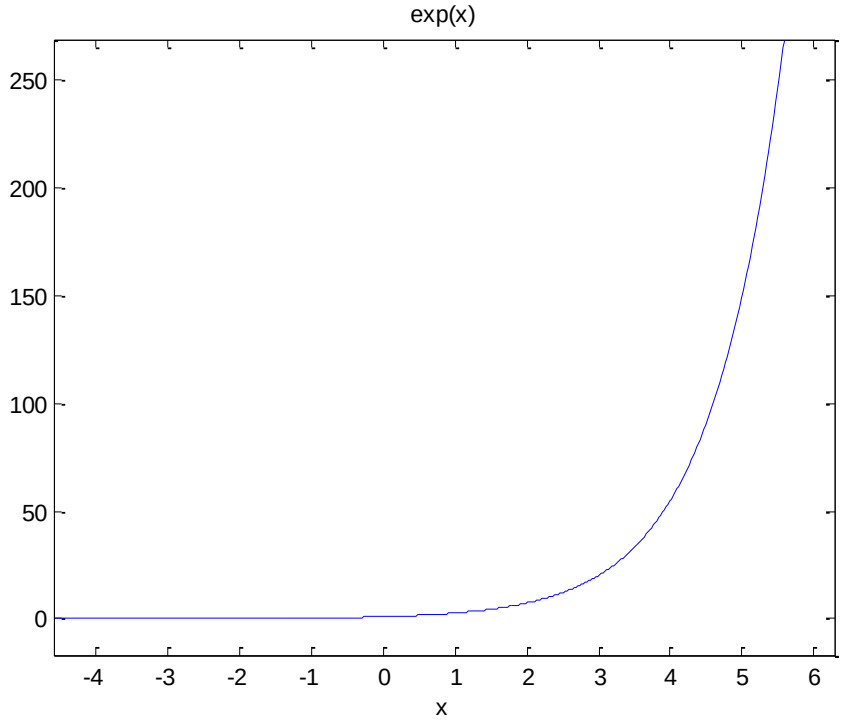


plot(Z) is equivalent to **plot(real(Z), imag(Z))**.

ezplot

- ezplot(f) plots f(x) in [-2π, 2π].
- ezplot(f, a, b) or ezplot(f, [a, b]) plot f(x) in [a,b]
- ezplot(f, [xmin xmax ymin ymax])

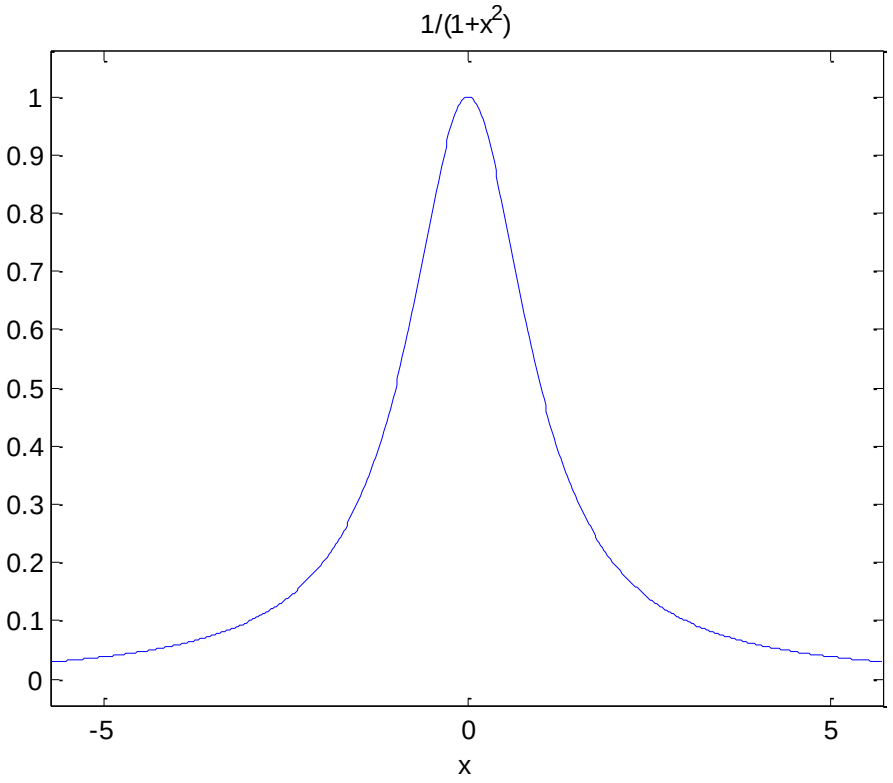
```
>> ezplot('exp(x)')
```



Example 1

$$f(x) = \frac{1}{1+x^2}$$

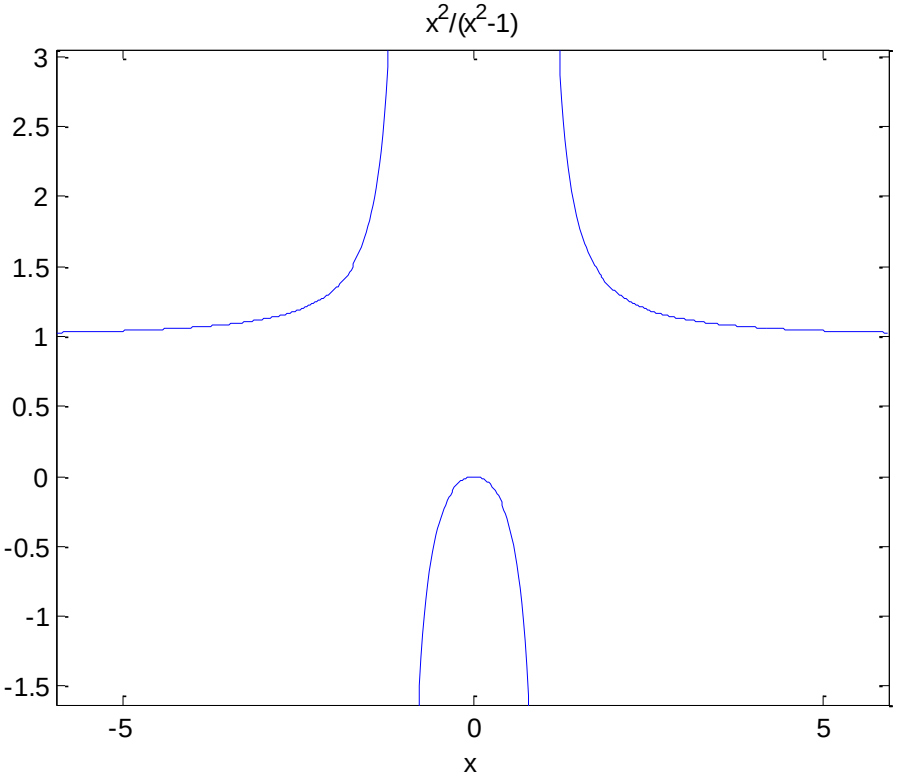
```
>> ezplot('1./(1+x.^2)')
```



Example 2

$$f(x) = \frac{x^2}{x^2 - 1}$$

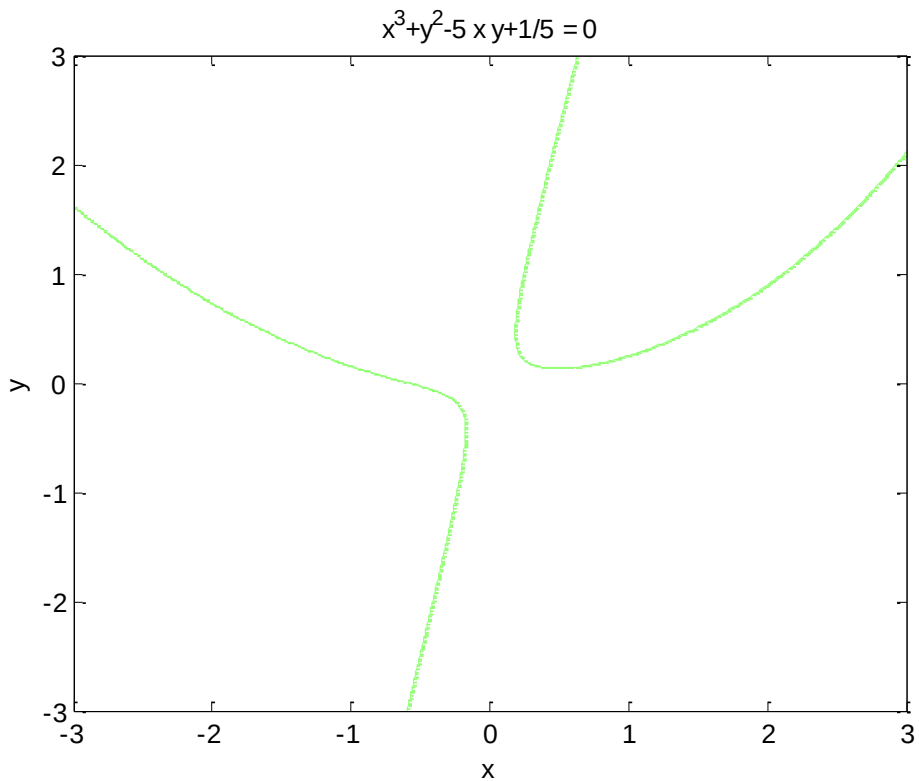
```
>> f = @(x) x.^2./(x.^2-1);
>> ezplot(f)
```



ezplot: implicit functions

$$f(x,y) = x^3 + y^2 - 5xy + \frac{1}{5} = 0$$

```
>> ezplot('x^3+y^2-5*x*y+1/5',[-3,3])
```

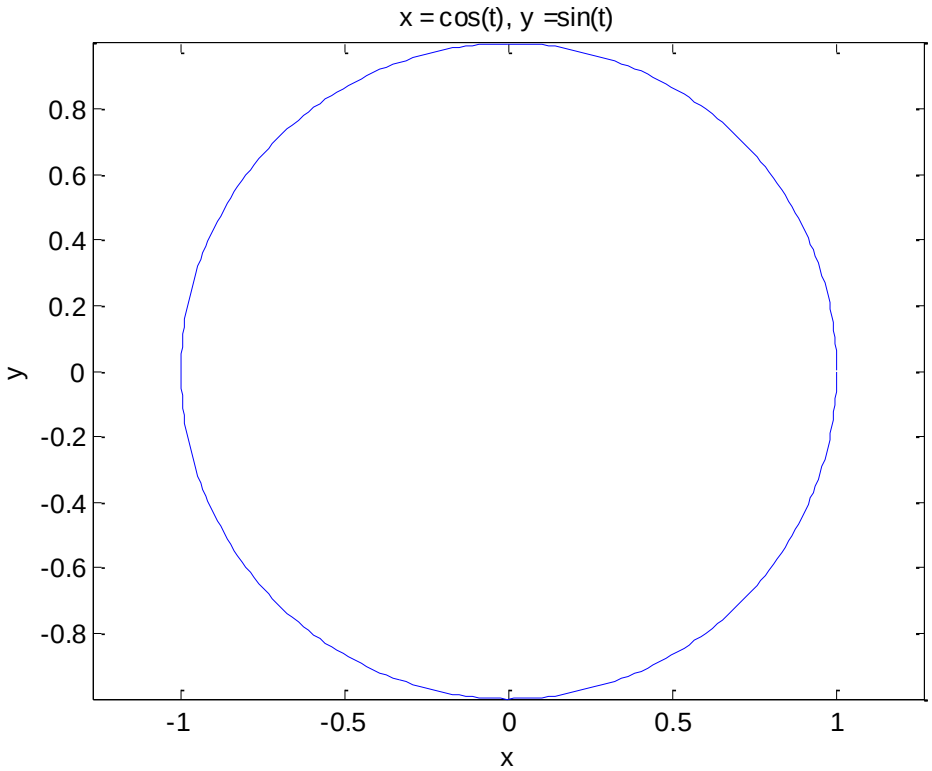


ezplot: parametric curves

$$x = x(t), \quad y = y(t), \quad t \in [a,b]$$

ezplot('x(t)', 'y(t)', [a,b])

```
>> ezplot('cos(t)', 'sin(t)',[0,2*pi])
```

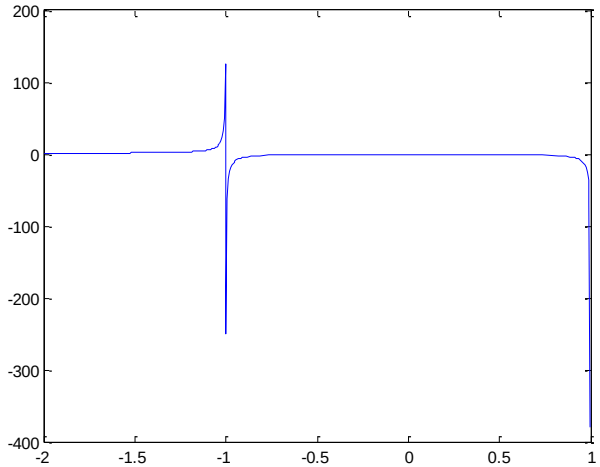


fplot

fplot(f, [xmin, xmax])

fplot(f, [xmin, xmax, ymin, ymax])

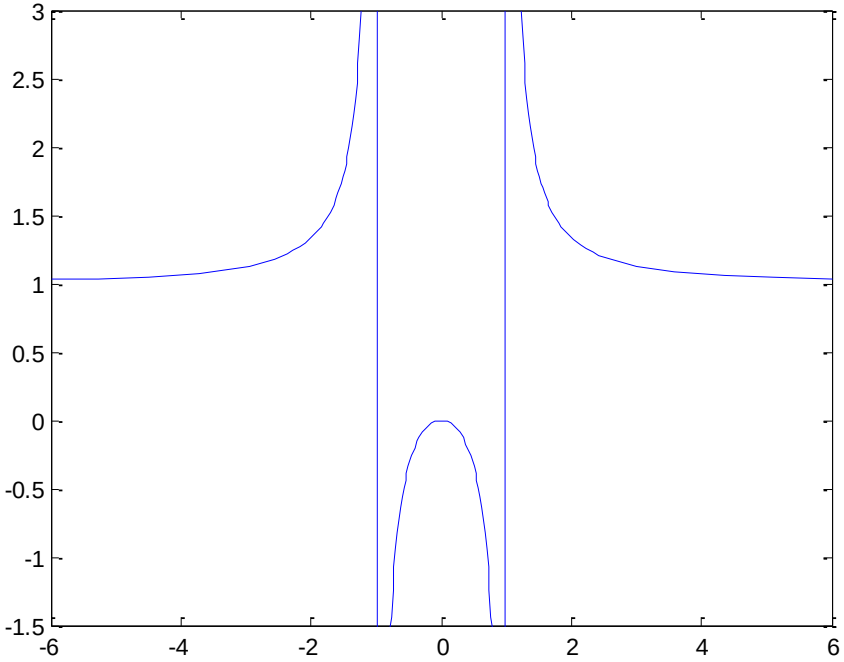
```
>> f = @(x) x.^2./(x.^2-1);
>> fplot(f, [-2,1])
```



$$f(x) = \frac{x^2}{x^2 - 1}$$

fplot

```
>> f = @(x) x.^2./(x.^2-1);
>> fplot(f,[-6 6 -1.5 3])
```

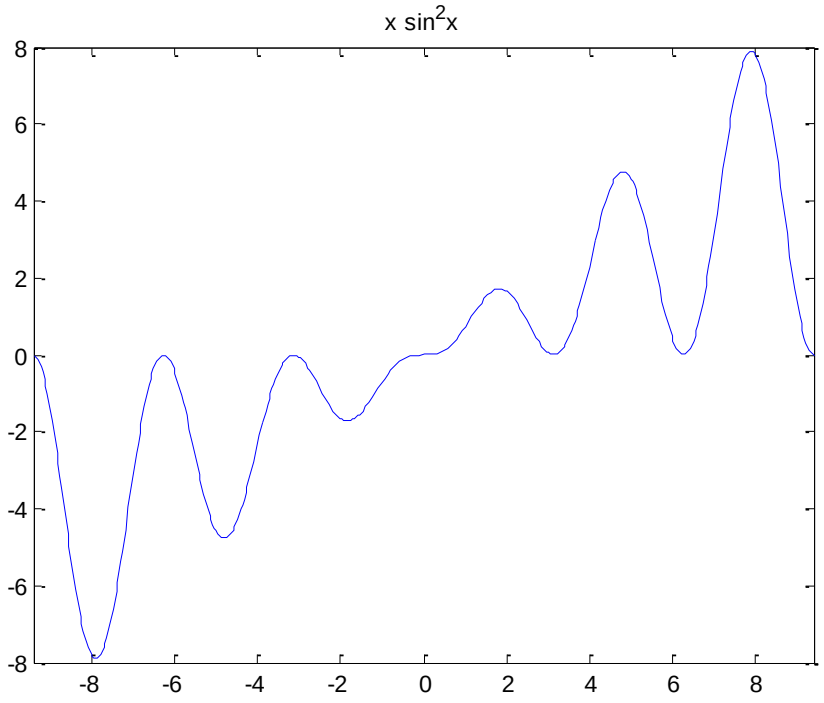


$$f(x) = \frac{x^2}{x^2 - 1}$$

fplot

$$f(x) = x\sin^2 x$$

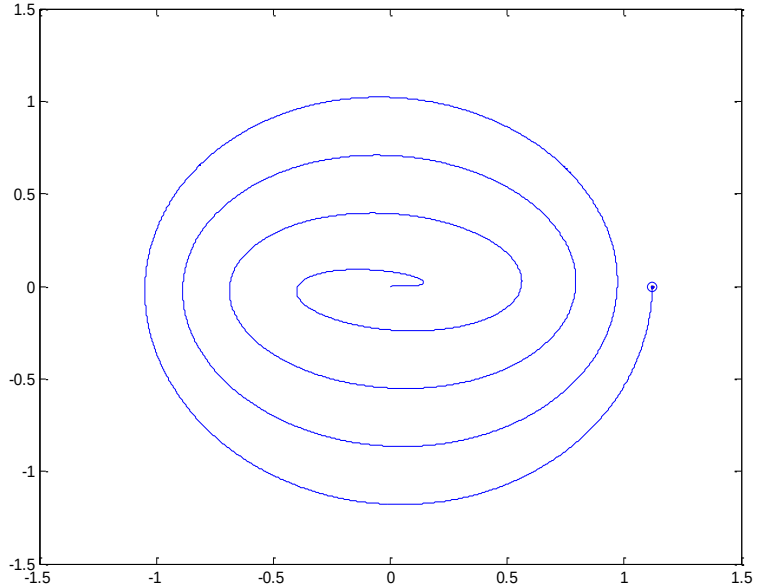
```
>>  fplot('x*sin(x)^2',[-3*pi, 3*pi]), title('x sin^2x')
```



comet

comet(x,y)

```
>> t=0:pi/1000:8*pi;
>> x=sqrt(t/20).*cos(t); y=t.*sin(t)/20;
>> comet(x,y)
```



$$x(t) = \sqrt{\frac{t}{20}}\cos t$$

$$y(t) = \frac{t\sin t}{20}$$

```
>> plot(x,y), hold on, comet(x,y)
```

Colors, lines, and symbols

plot(x,y, ' [color][stype][ltype]').

[color]	Color	Color
b	blue	**blue**
g	green	**green**
r	red	**red**
c	cyan	**cyan**
m	magenta	**magenda**
y	yellow	**yellow**
k	black	**black**
w	white	

[ltype]	Line type
-	solid
:	dotted
--	dashed
-.	dashdot

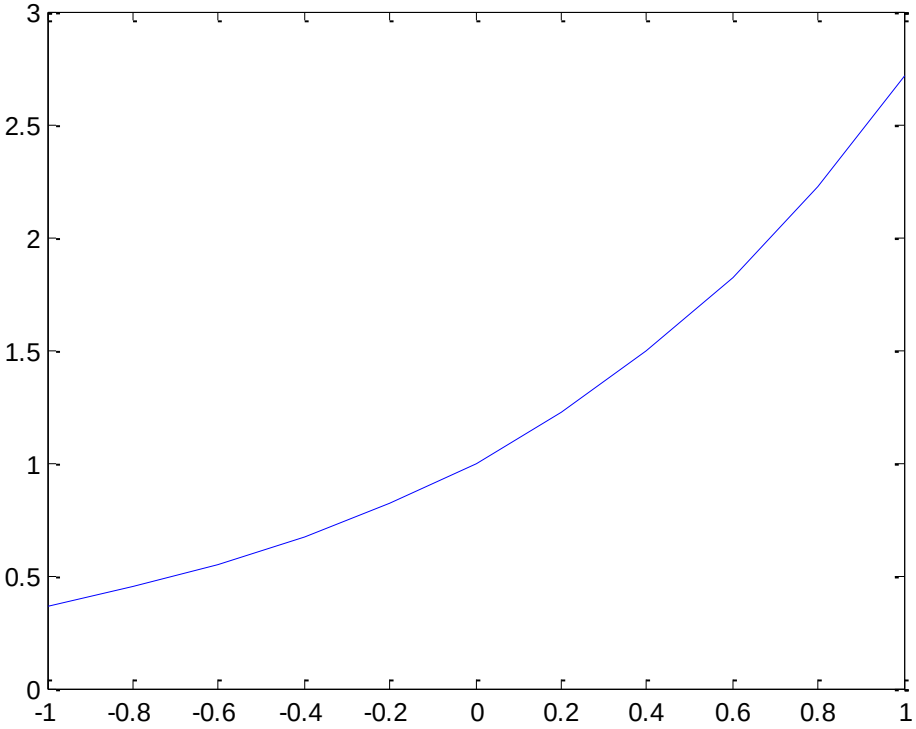
[stype]	Symbol
.	point
o	circle
x	x-mark
+	plus
*	star
s	square
d	diamond
v	triangle (down)
^	triangle (up)
<	triangle (left)
>	triangle (right)
p	pentagram
h	hexagram

Plot

```
>> x = -1:0.2:1;
>> y=exp(x);
>> plot(x, y)
```

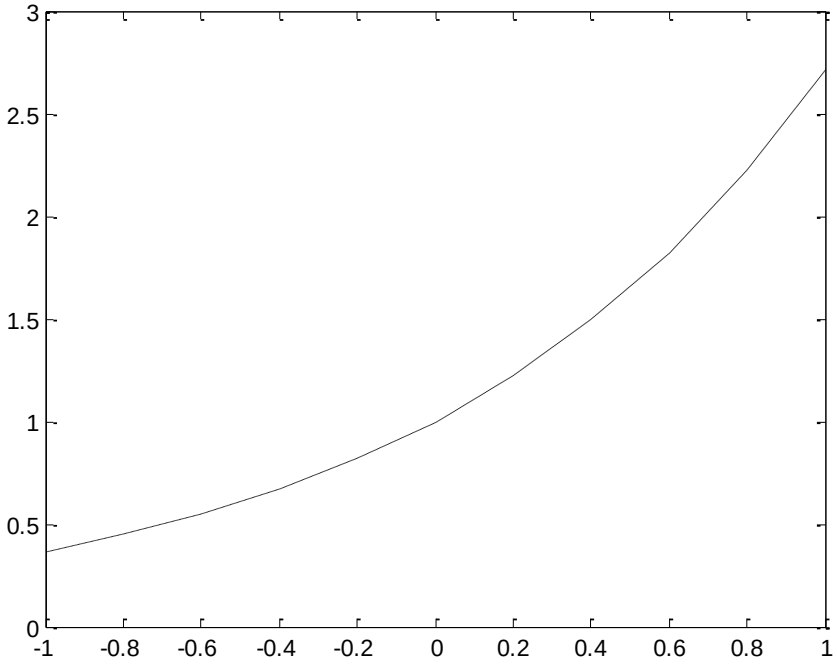
or

```
>>plot(x, y, 'b- ')
```



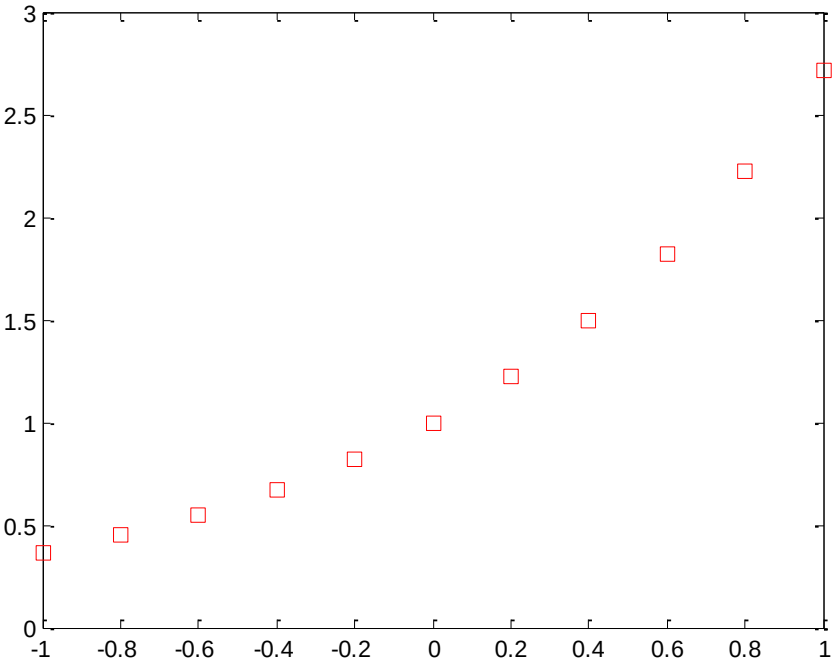
Plot

```
>> plot(x, y, 'k--')
```



Plot

```
>>  plot( x, y, 'rs')
```

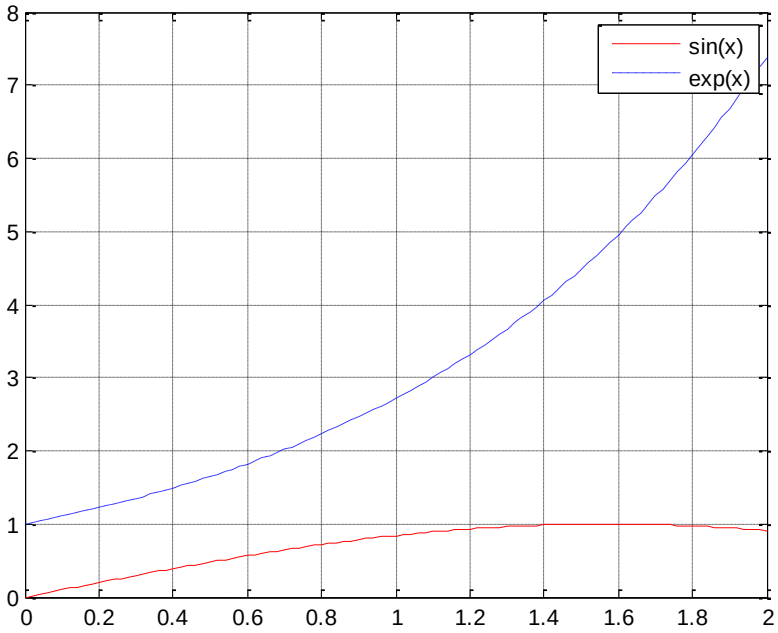


Multiple graphs

plot(x1, y1, ' [colour][stype][ltype]', x2, y2, ' [colour][stype][ltype]', …….)

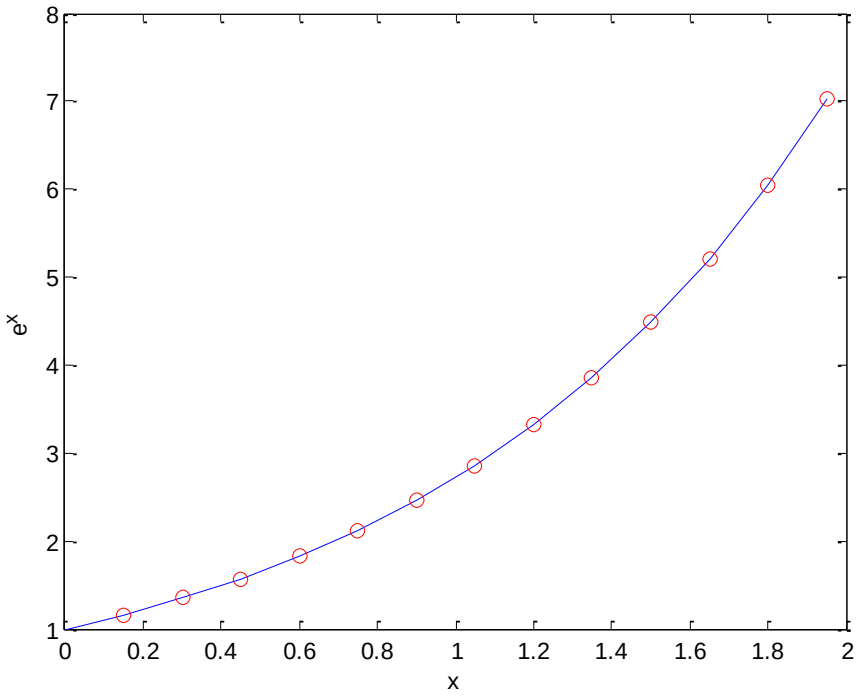
legend ('legend y1', 'legend y2', ……)

```
>> x=0:0.02:2;
>> y=sin(x);
>> z=exp(x);
>> plot( x, y, 'r', x, z, '--')
>> grid
>> legend ( 'sin(x)', 'exp(x)' )
```



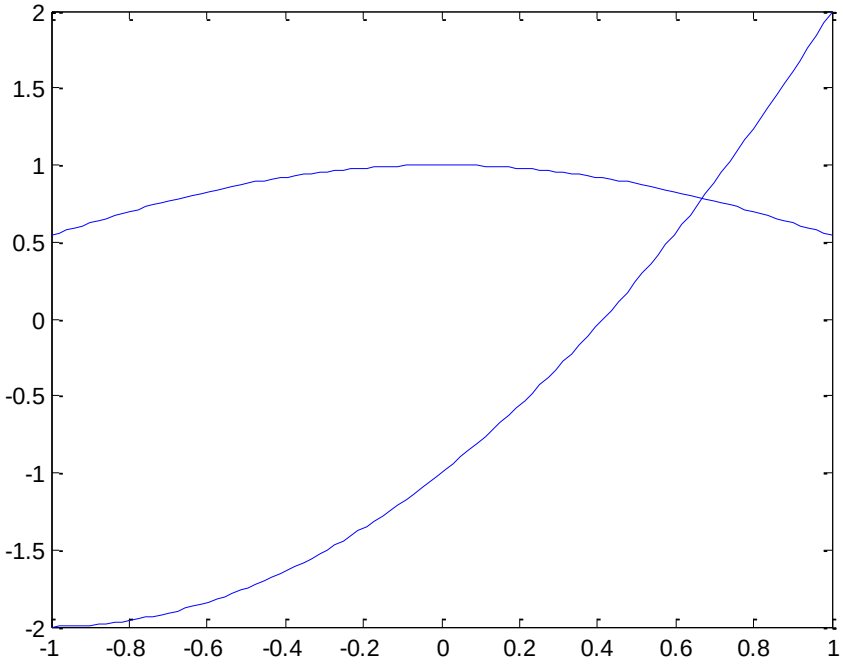
Plot

```
>> x=0:0.15:2;
>> y=exp(x);
>> plot( x, y, 'b', x, y, 'ro')
>> xlabel('x')
>> ylabel('e^x')
```



hold

```
>> t=linspace(-1,1);
>> y=t.^2 + 2*t -1;
>> plot(t,y)

>> hold on
>> z=cos(t)
>> plot(t,z)
>> hold off
```



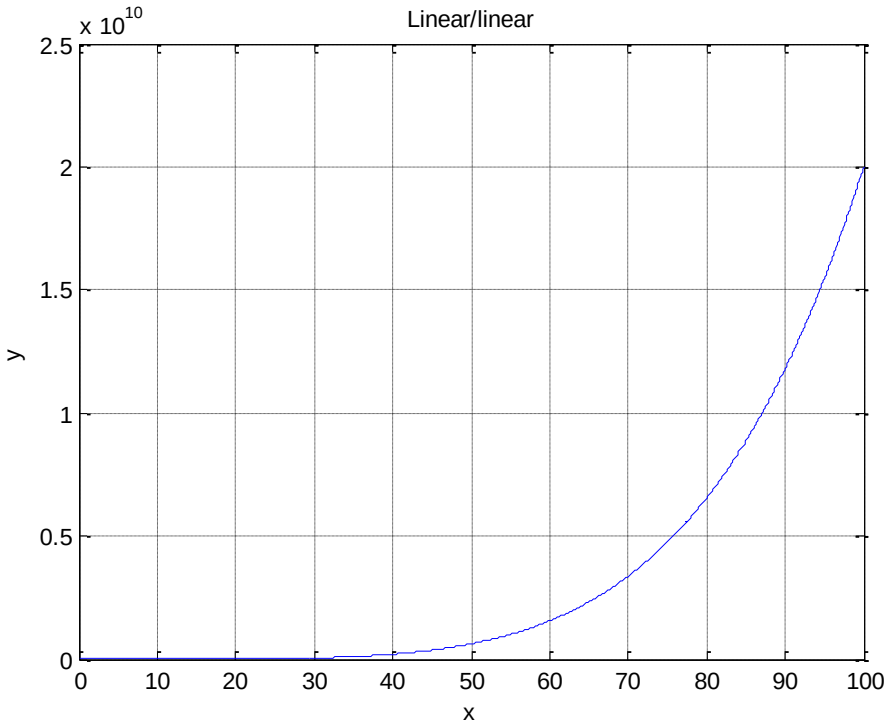
Logarithmic plots

```
plot(x,y)

loglog(x,y)

semilogx(y)

semilogy(x,y)
```

$$y = 1 + x^5$$

plot

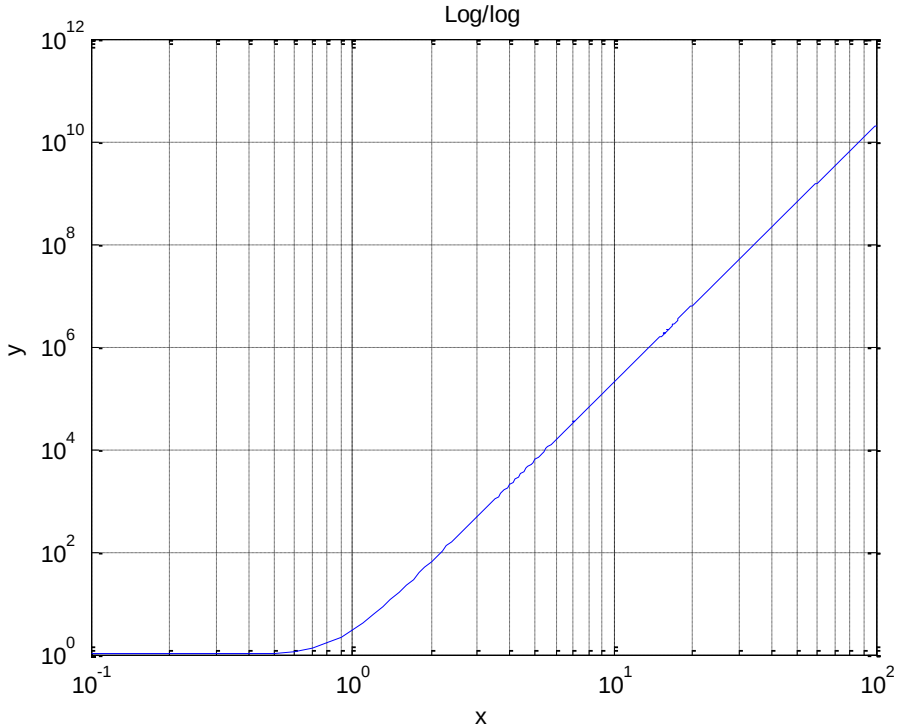
```
>> x=0:0.1:100;
>> y=1+2*x.^5;
 >> plot(x,y), grid, xlabel('x'), ylabel('y')
>> title('Linear/linear')
```



$$y = 1 + x^5$$

loglog(x,y)

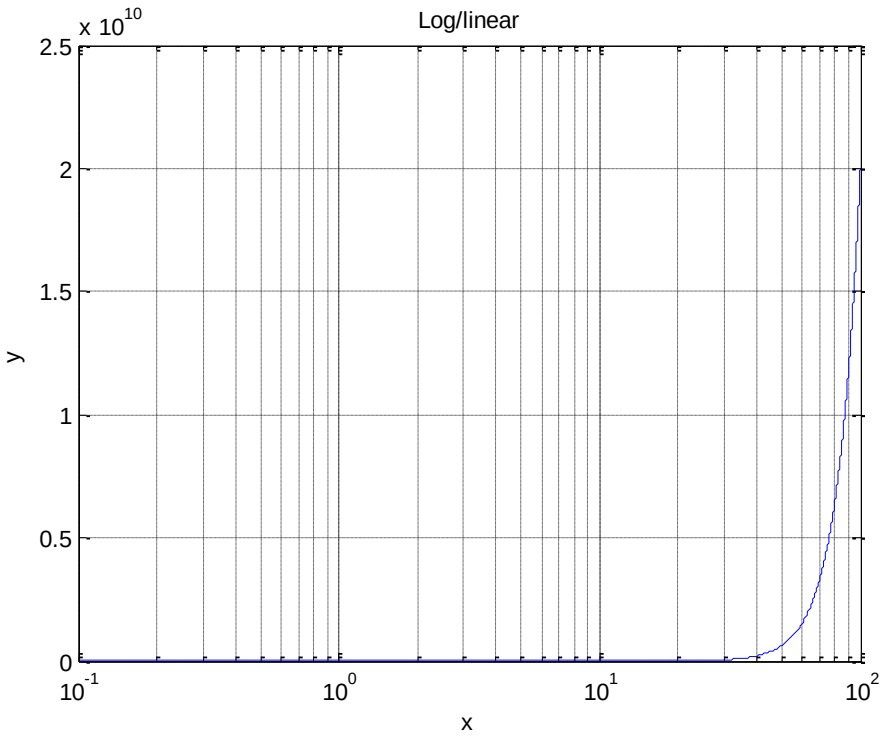
```
>> loglog(x,y), grid, xlabel('x'), ylabel('y')
>> title('Log/log')
```



$$y = 1 + x^5$$

semilogx(x,y)

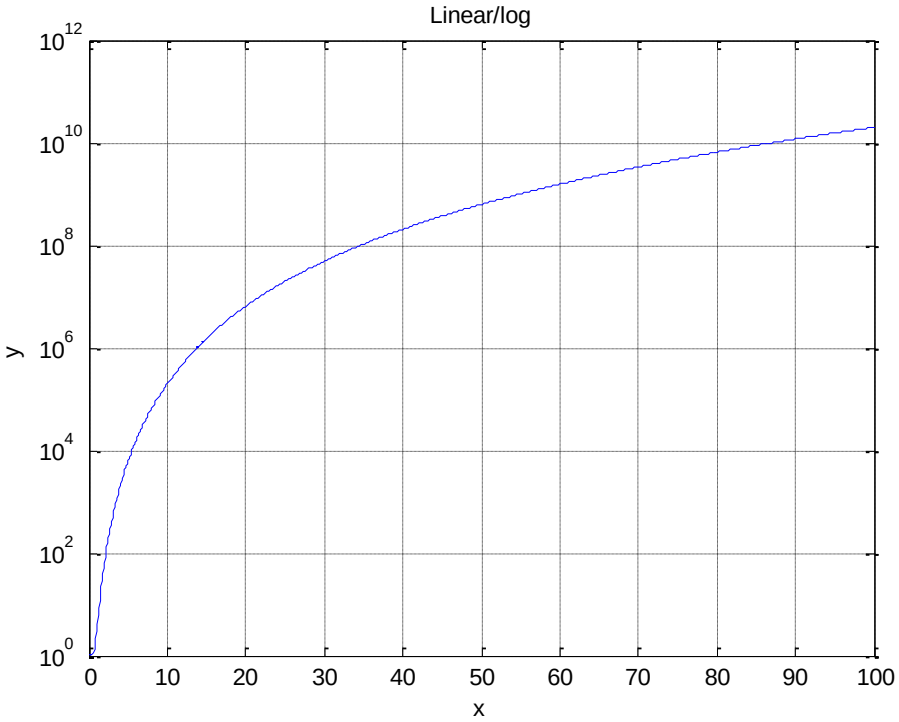
```
>> semilogx(x,y), grid, xlabel('x'), ylabel('y')
>> title('Log/linear')
```



$$y = 1 + x^5$$

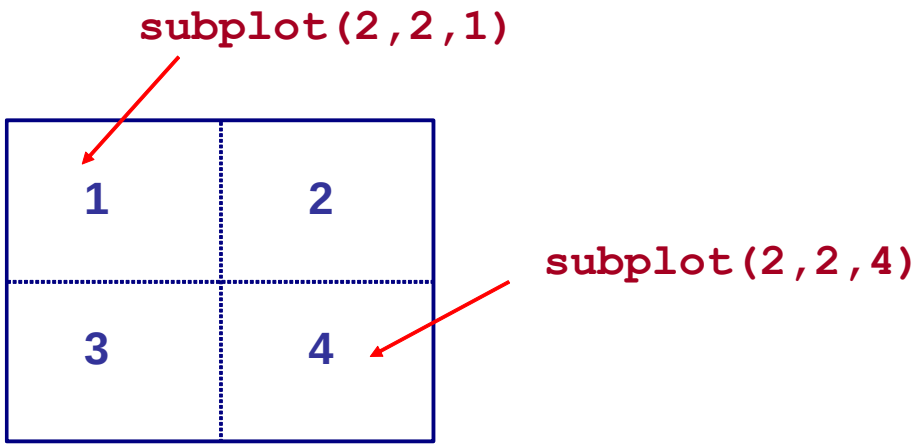
semilogy(x,y)

```
>> semilogy(x,y), grid, xlabel('x'), ylabel('y')
>> title('Linear/log')
```



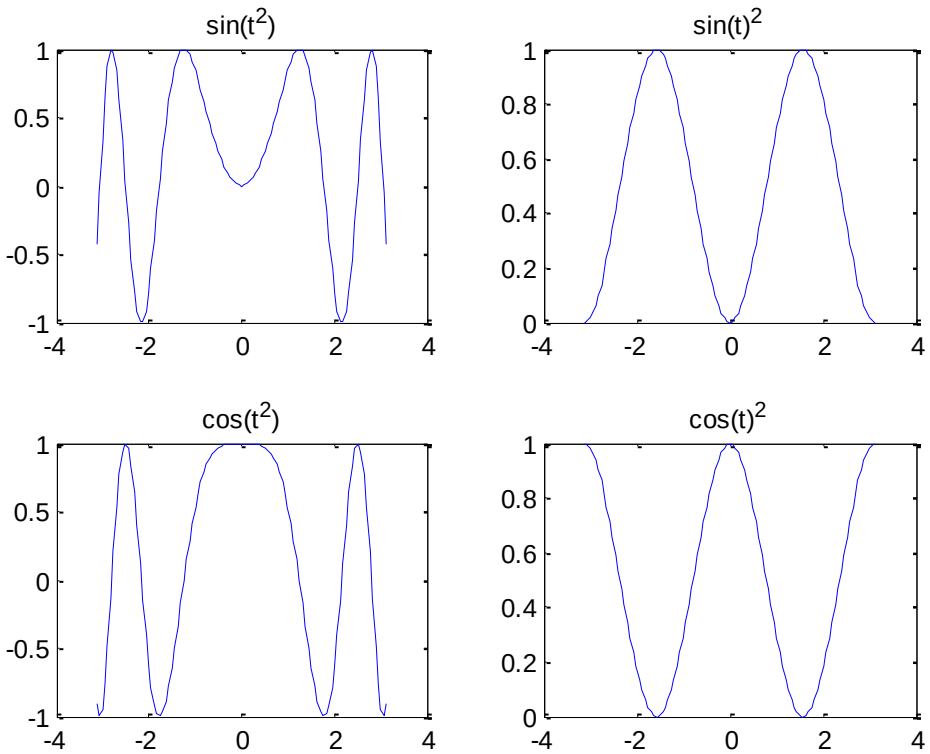
Multiple plots

subplot(m,n,p)



Example

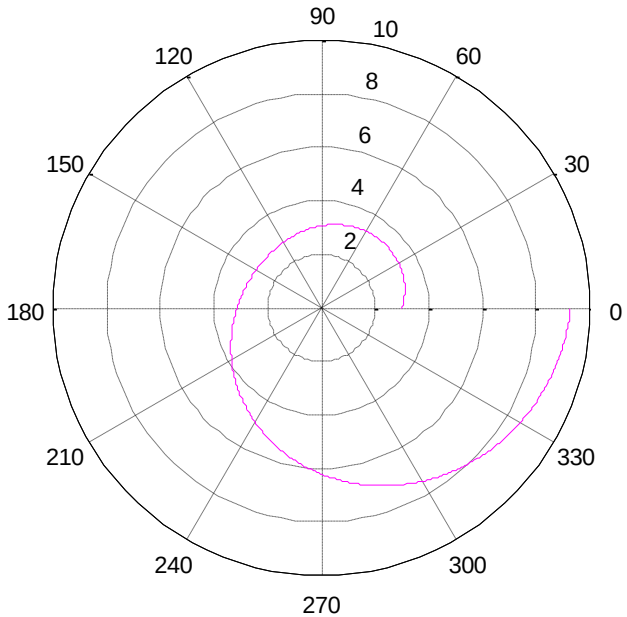
```
>> t = -pi:2*pi/100:pi;
>>f1=sin(t.^2);
>>f2=(sin(t)).^2;
>>f3=cos(t.^2);
>>f4=(cos(t)).^2;
>>subplot(2,2,1);plot(t,f1);
>>title('sin(t^2)')
>>subplot(2,2,2);plot(t,f2);
>>title('sin(t)^2')
>>subplot(2,2,3);plot(t,f3);
>>title('cos(t^2)')
>>subplot(2,2,4);plot(t,f4);
>>title('cos(t)^2')
```



Graphs in polar coordinates

polar(theta,r)

```
>> t=0:0.01:2*pi;
>> r=3*cos(t/2).^2+t;
>> polar(t,r, 'm')
```

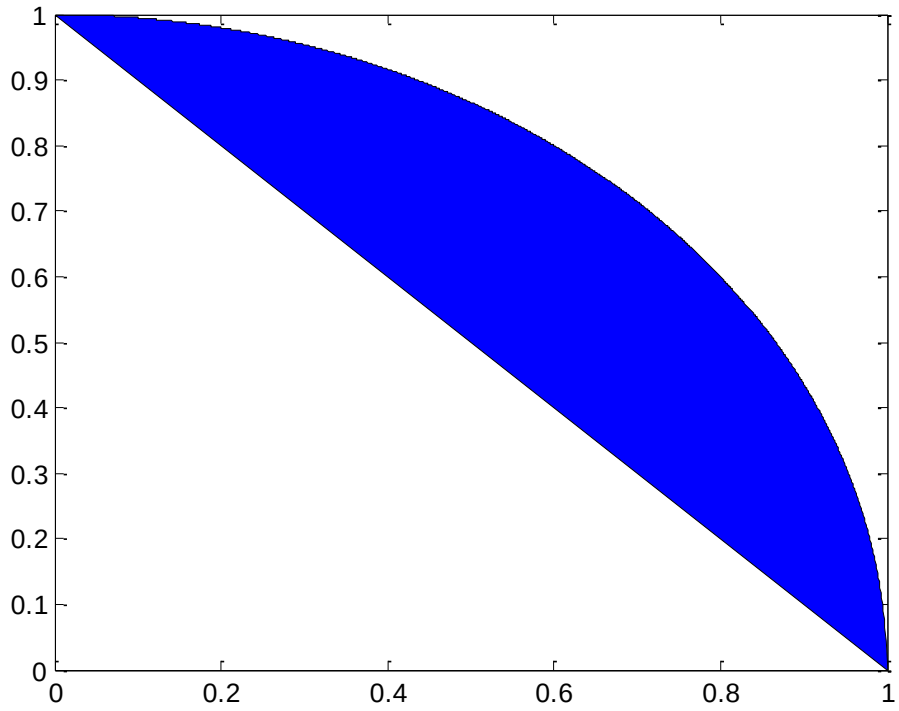


$$r = 3\cos^2\frac{\theta}{2} + \theta$$

fill

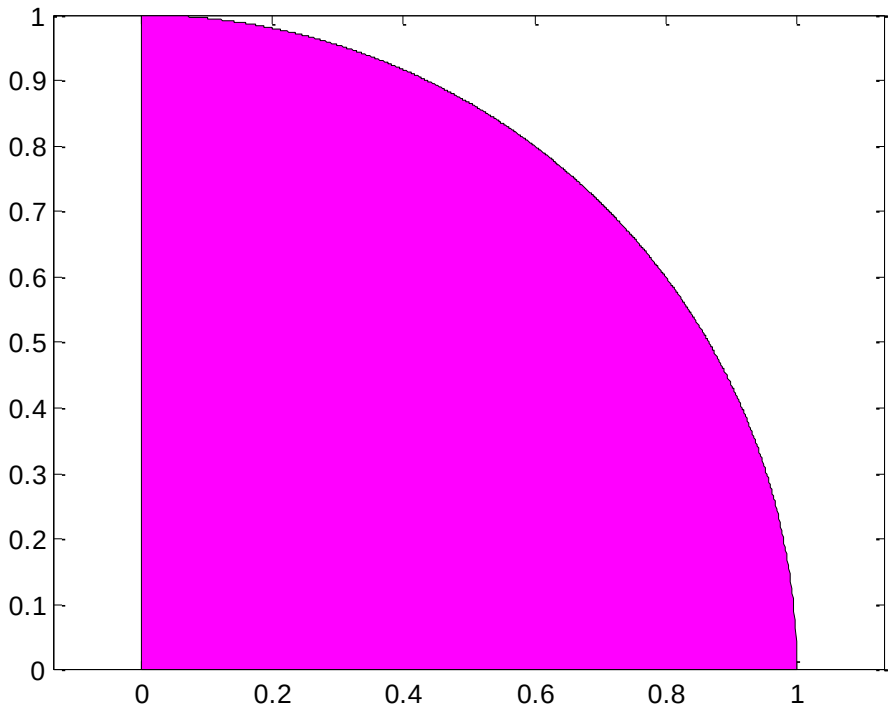
fill(X,Y,C) fills the 2-D polygon defined by vectors X and Y with the color specified by C.

```
>> x=linspace(0,1,1001); y=sqrt(1-x.^2);
>> fill(x,y,'b')
```



fill

```
>> x=linspace(0,1,1001); y=sqrt(1-x.^2);
>> X=[x 0]; Y=[y 0];
>> fill(X,Y,'m'), axis equal
```

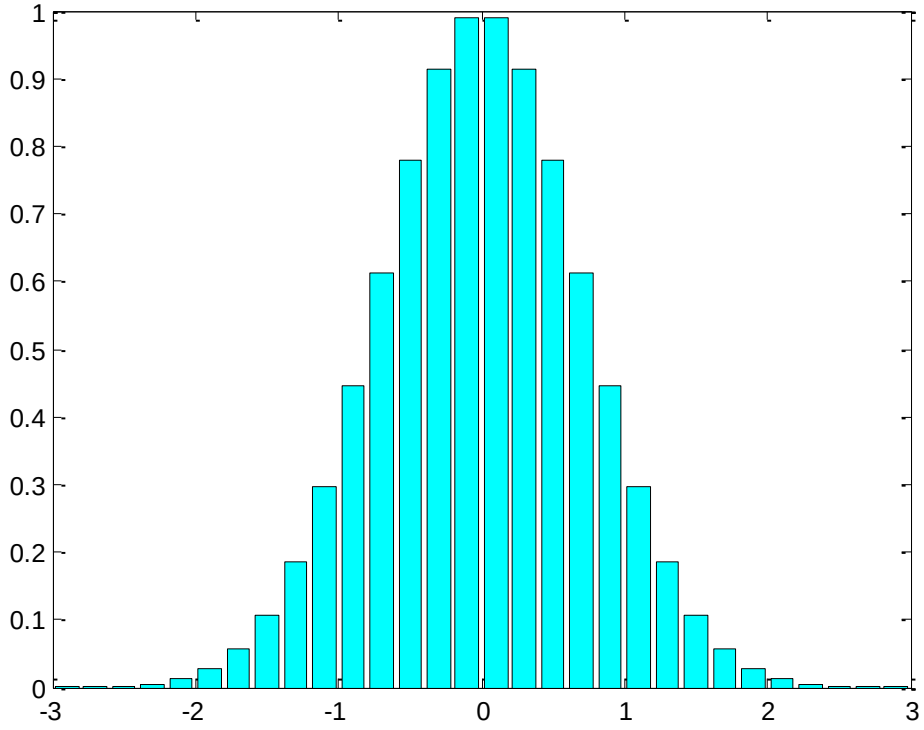


Bar and area graphs

```
bar(x)

barh(x)

bar3(x)

bar3h(x)

area(x)
```

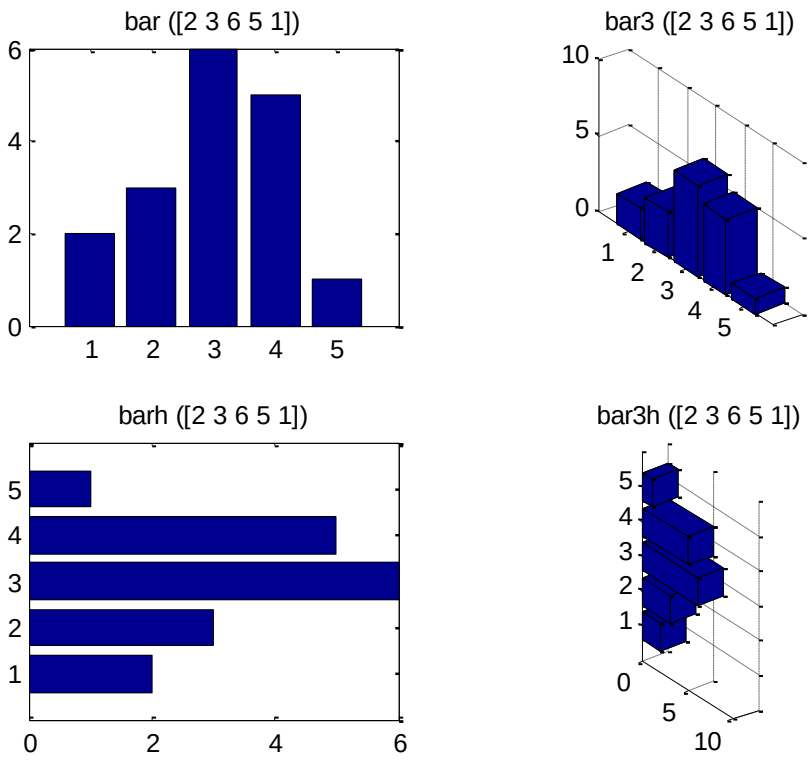
Example 1

```
>> x = -2.9:0.2:2.9;
>> y=exp(-x.^2);
>> bar(x,y)
>> colormap cool
```



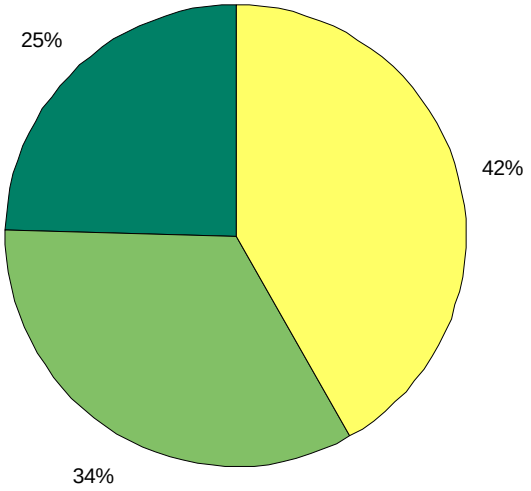
Example 2

```
>> x=[2 3 6 5 1];
>> subplot(2,2,1), bar(x), title('bar ([2 3 6 5 1])')
>> subplot(2,2,2), bar3(x), title('bar3 ([2 3 6 5 1])')
>> subplot(2,2,3), barh(x), title('barh ([2 3 6 5 1])')
>> subplot(2,2,4), bar3h(x), title('bar3h ([2 3 6 5 1])')
```

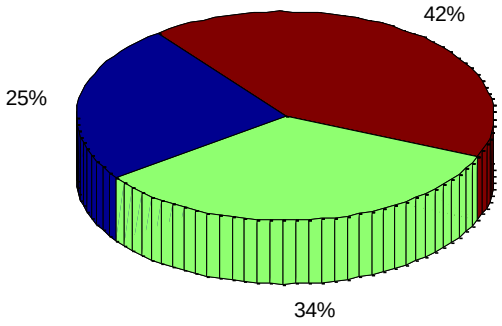


Pie charts

```
>> x=[194.8,266.5,330.9];
>> pie(x)
```

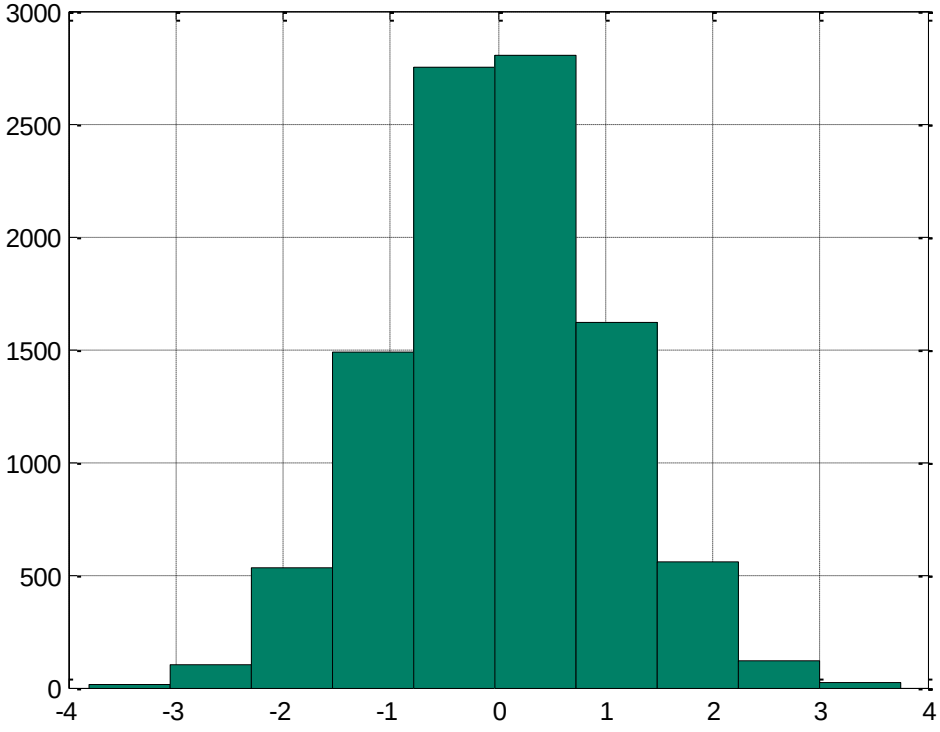



```
>> pie3(x)
```



Histograms

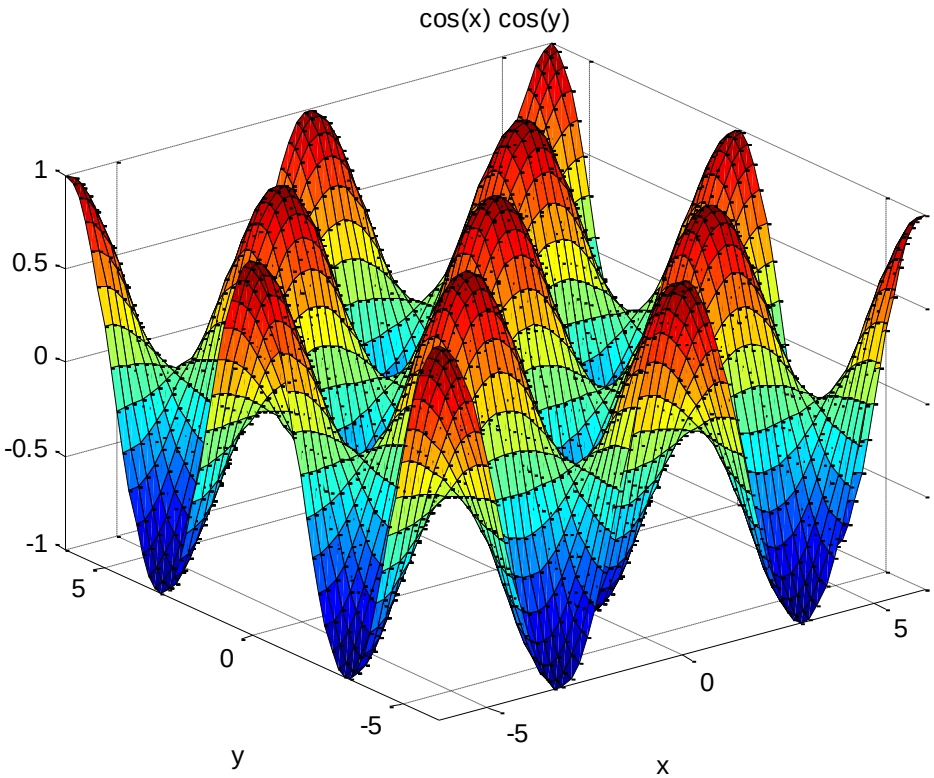
```
>> y=randn(10000,1);
>> hist(y)
>> grid
```



3D plots

ezsurf

```
>> z = @(x,y) cos(x).*cos(y);
>> ezsurf(z)
```

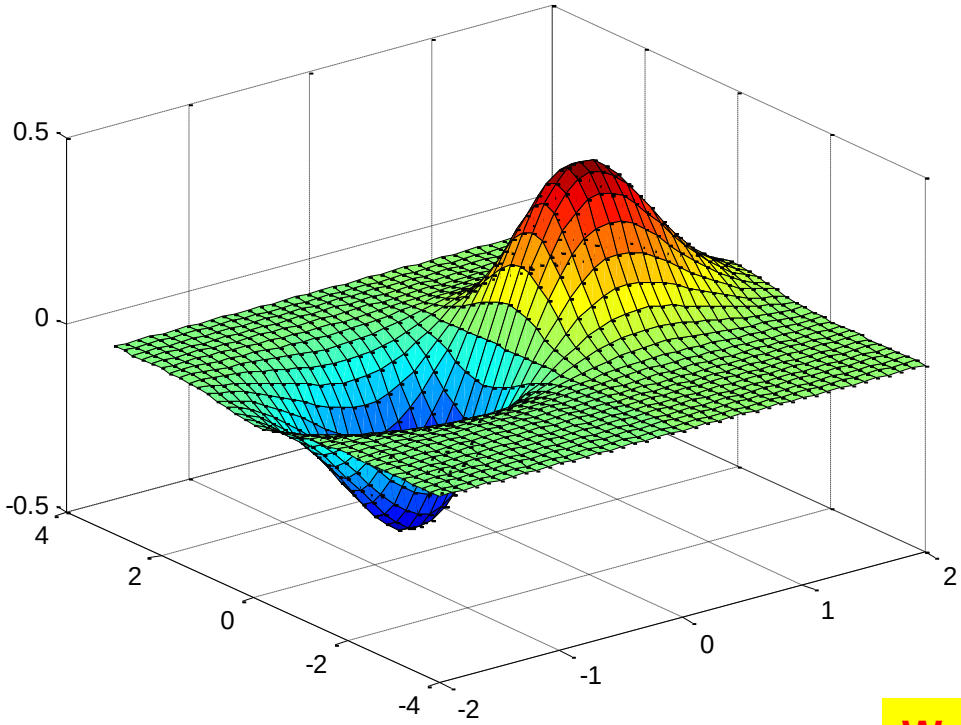


$$z = \cos x \cos y$$

3D plots

meshgrid and surf

```
>> [x,y] = meshgrid(-2:0.1:2, -4:0.2:3);
>> z = x .* exp(-x.^2 - y.^2);
>> surf(x,y,z)
```



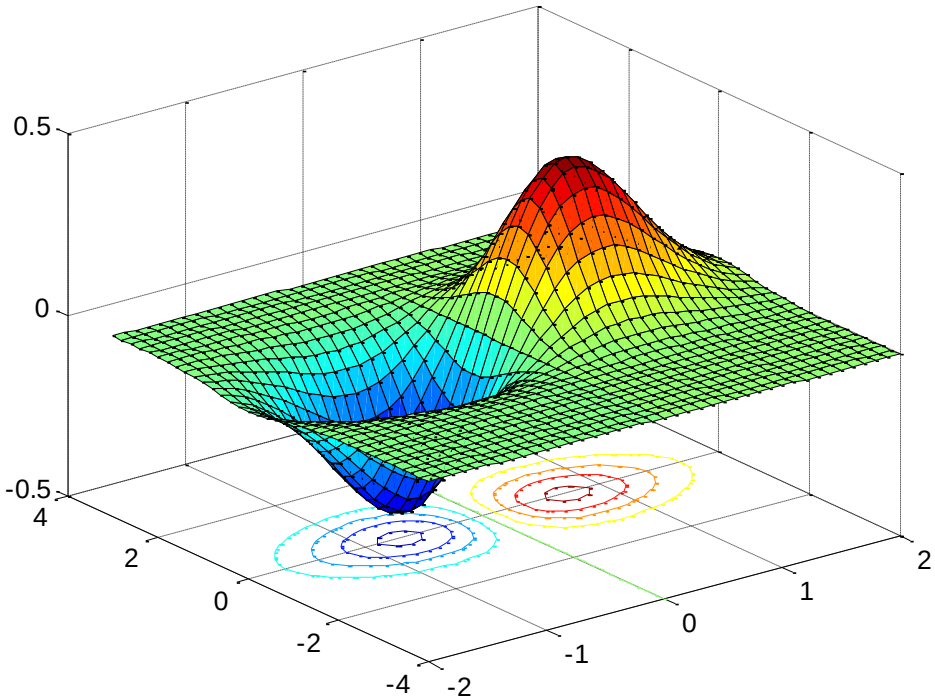
$$z = xe^{-x^2-y^2}$$

We can put axis labels!

3D plots

surfc

```
>> [x,y] = meshgrid(-2:0.1:2, -4:0.2:3);
>> z = x .* exp(-x.^2 - y.^2);
>> surfc(x,y,z)
```

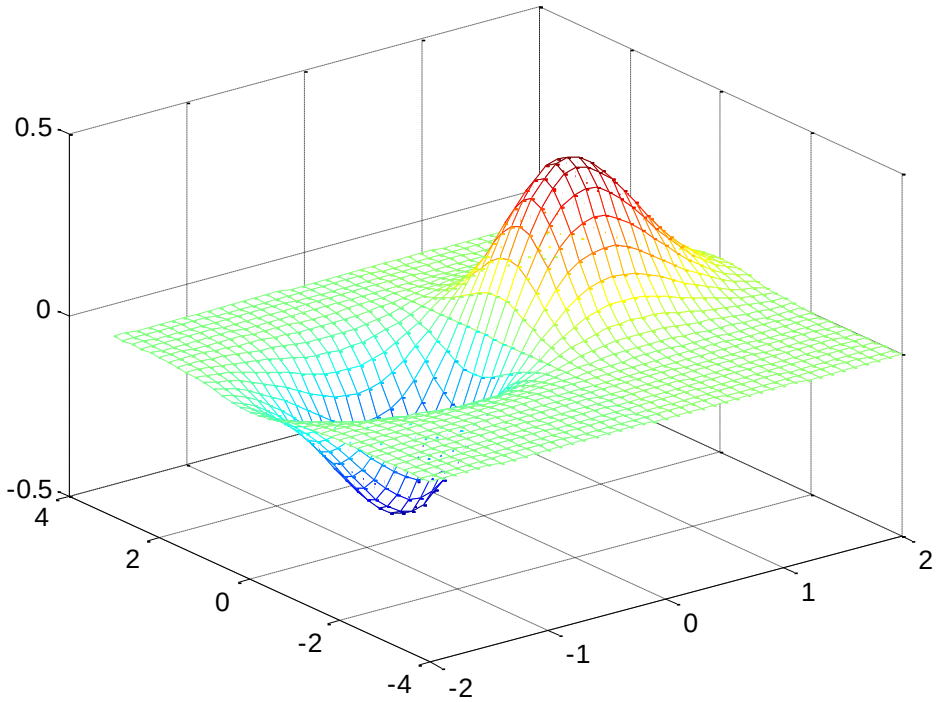


$$z = xe^{-x^2-y^2}$$

3D plots

mesh

```
>> [x,y] = meshgrid(-2:0.1:2, -4:0.2:3);
>> z = x .* exp(-x.^2 - y.^2);
>> mesh(x,y,z)
```

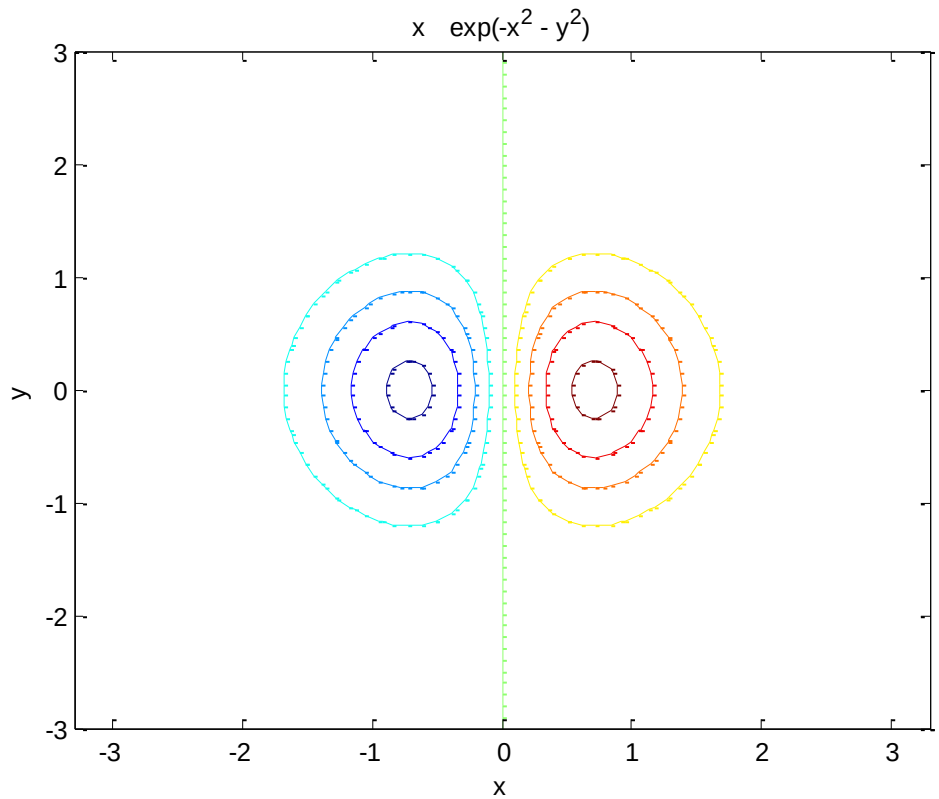


$$z = xe^{-x^2-y^2}$$

Contour plots

ezcontour

```
>>  z = @(x,y) x .* exp(-x.^2 - y.^2);
>> ezcontour(z)
```

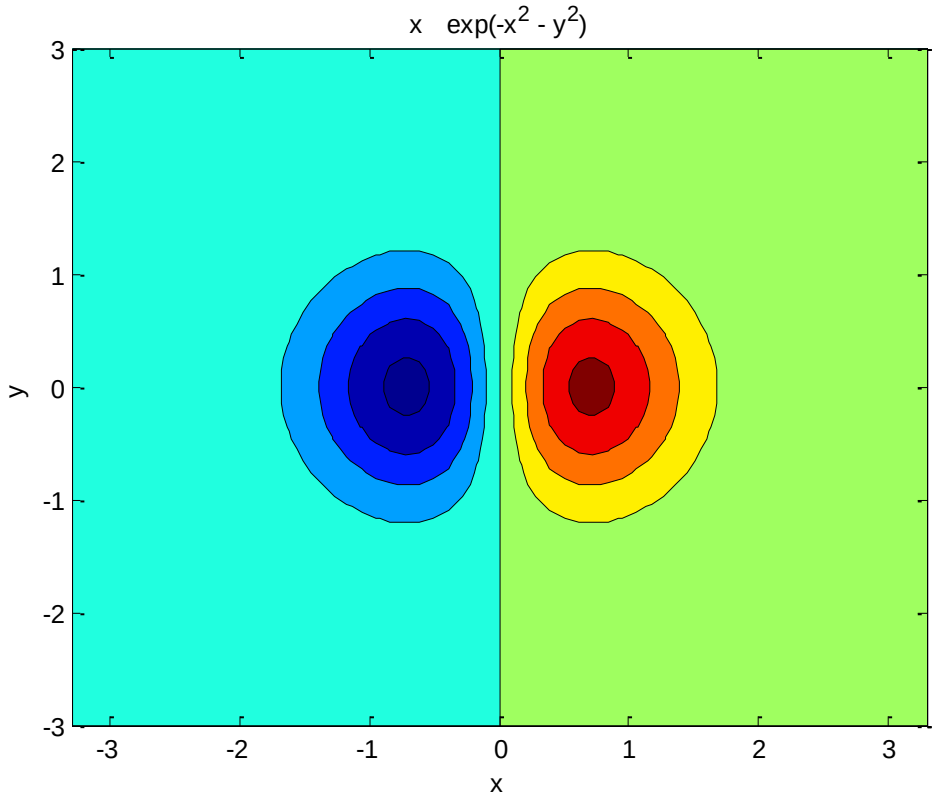


$$z = xe^{-x^2-y^2}$$

Contour plots

ezcontourf

```
>>  z = @(x,y) x .* exp(-x.^2 - y.^2);
>> ezcontourf(z)
```

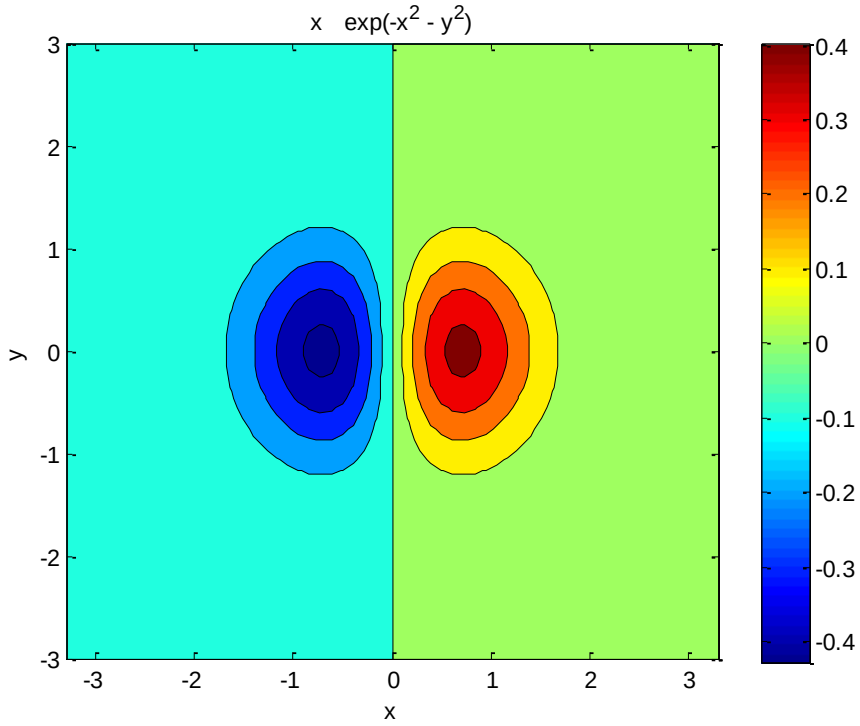


$$z = xe^{-x^2-y^2}$$

Contour plots

colorbar

```
>>  z = @(x,y) x .* exp(-x.^2 - y.^2);
>> ezcontourf(z)
>> colorbar
```

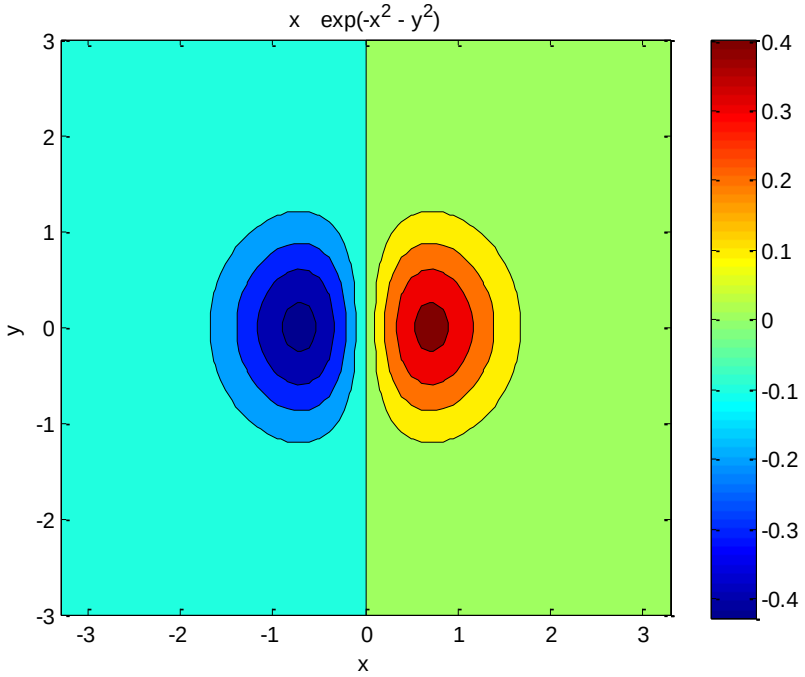


$$z = xe^{-x^2-y^2}$$

Η εντολή

```
>> colorbar
```

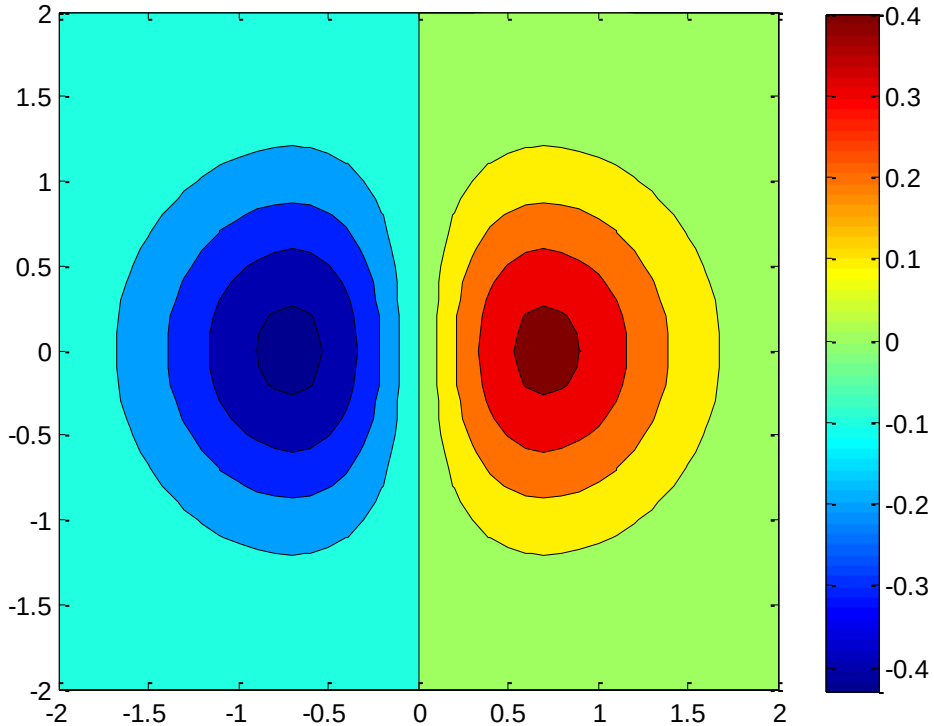
προσθέτει λεζάντα για το κάθε χρώμα, όπως φαίνεται πιο κάτω:



Contour plots

contour, contourf

```
>>  [x,y] = meshgrid(-2:0.1:2, -2:0.1:2);
>> z = x .* exp(-x.^2 - y.^2);
>> contourf(x,y,z), colorbar
```



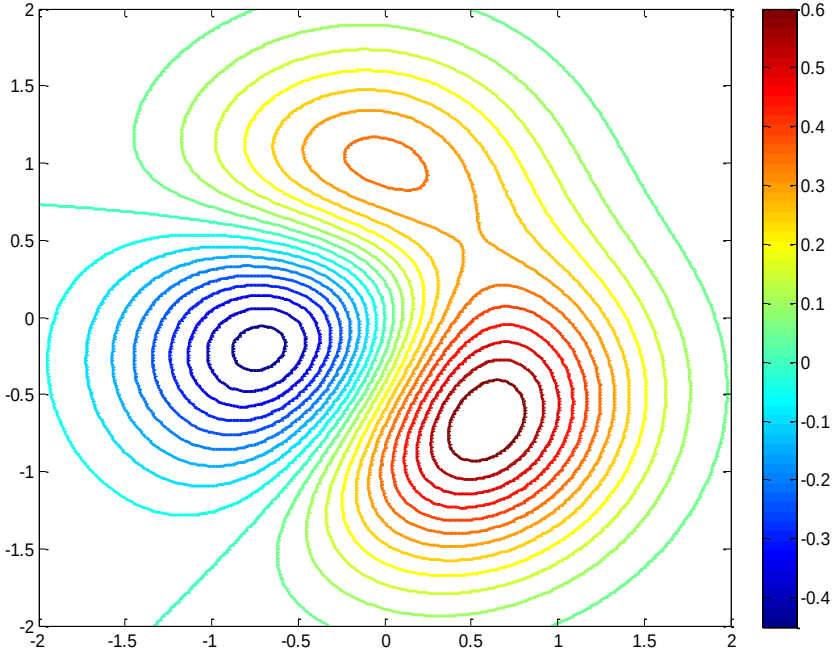
$$z = xe^{-x^2-y^2}$$

contour, contourf

```
contour(x,y,z,n)

contour(x,y,z,v)

contourf(x,y,z,v)

contour(x,y,z,[v v])

contourf(x,y,z,[v v])
```

Example 1

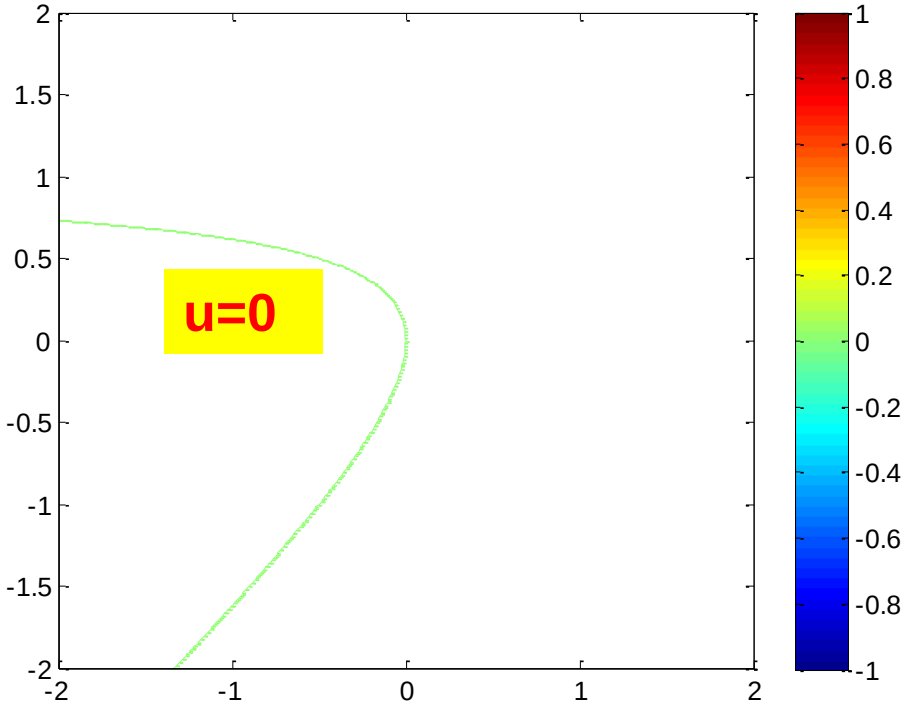
```
>> [x,y]=meshgrid(-2:0.02:2,-2:0.02:2);
>> z=(x-x.*y+y.^2).*exp(-x.^2-y.^2);
>> contour(x,y,z,-.5:0.05:5,'Linewidth',2), colorbar
```



$$z = (x - xy - y^2)e^{-x^2-y^2}$$

Example 2

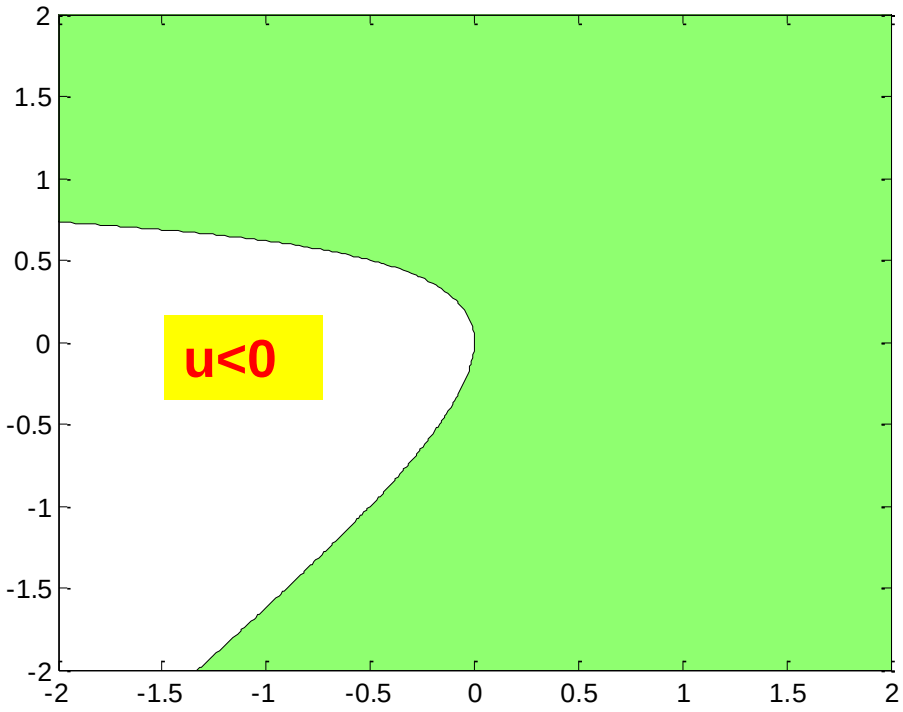
```
>> [x,y]=meshgrid(-2:0.02:2,-2:0.02:2);
>> z=(x-x.*y+y.^2).*exp(-x.^2-y.^2);
>> contour(x,y,z,[0 0]), colorbar
```



$$z = (x - xy - y^2)e^{-x^2-y^2}$$

Example 3

```
>> [x,y]=meshgrid(-2:0.02:2,-2:0.02:2);
>> z=(x-x.*y+y.^2).*exp(-x.^2-y.^2);
>> contourf(x,y,z,[0 0])
```

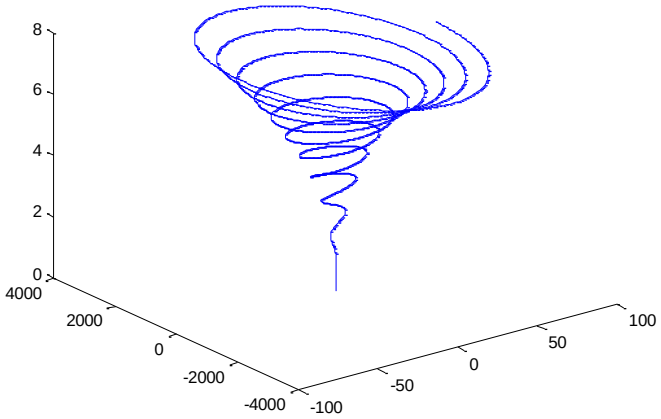


$$z = (x - xy - y^2)e^{-x^2-y^2}$$

3D curves: plot3

$$x(t) = t\cos t, \quad y(t) = t^2 \sin t, \quad z(t) = \sqrt{t}, \quad t \in [0, 20\pi]$$

```
t=0:pi/100:20*pi;
x=t.*cos(t);
y=t.^2.*sin(t);
z=sqrt(t);
plot3(x,y,z)
```



comet3

```
>> t=0:pi/100:20*pi;
>> x=t.*cos(t);
>> y=t.^2.*sin(t);
>> z=sqrt(t);
>> comet3(x,y,z)
```

Storing a figure in a file: print

print -device -options filename

Examples

print -djpeg -r150 figu
Store current figure into ‘figu.jpg’ with a 150 digit resolution

print
Sends the current figure to your current printer.

print –dps ‘foo’
Save the current figure to a postscript file named 'foo.ps'

Device options

-dwinc : Send figure to current printer in color
-dmeta : Send figure to clipboard (or file) in Metafile format
-dpsc : PostScript for color printers
-dpsc2 : Level 2 PostScript for color printers
-depsc : Encapsulated Color PostScript
-depsc2 : Encapsulated Level 2 Color PostScript
-djpeg<nn> : JPEG image, quality level of nn
-dtiff : TIFF with packbits (lossless run-length encoding) compression

print -depsc -tiff -r300 matilda

Saves current figure at 300 dpi in color EPS to matilda.eps with a TIFF preview

See help print for more info!

Thank you!!