Information technology – lecture 7

Plotting and 3D graphics in Octave.

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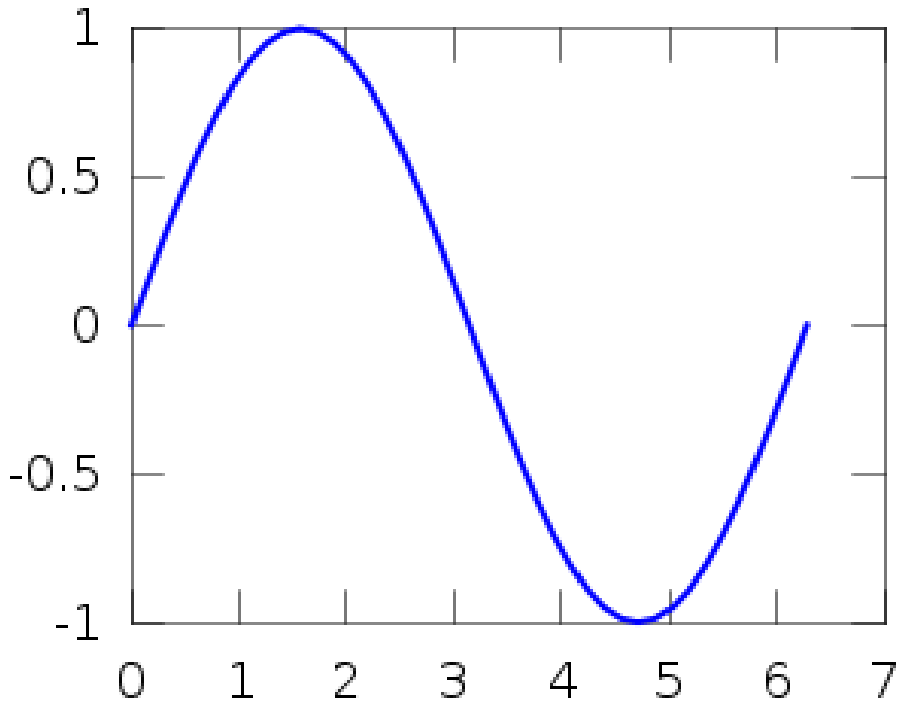
Plotting functions in 2D

Function	Description
`plot(x,y)`	plot function `y(x)`
`plot(y)`	plot function `y(x)` assuming `x=1:length(y);`
`plot(x,y,'s')`	plot function `y(x)` with specific line type;
`plot(x1,y1,x2,y2,···)`	plot many functions in one window;

```
disp("Function plotting");
x = [0:pi/20:2*pi];
y = sin(x);
plot(x,y);
pause();
print("rysunek1.png")
```



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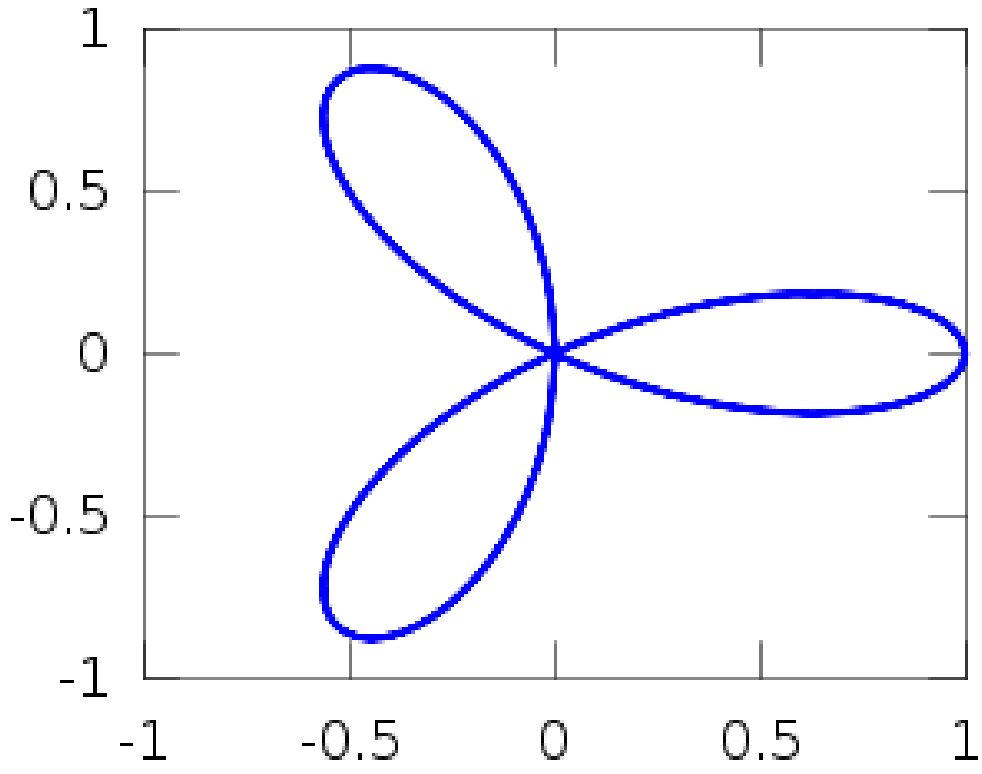
Example

```
t = [0:0.01:2*pi];
r = cos(3*t);
x = r.*cos(t);
y = r.*sin(t);
plot(x,y);
print("rysunek3.png");
```



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Function for plot annotations

Function	Description
`xlabel('text')`	display legend `text` for `x` axis
`ylabel('text')`	display legend `text` for `y` axis
`title('text')`	set plot title
`text(x,y,'text')`	put `text` at given position
`legend(s1,s2,···)`	put functions legend; `s1` is legend for the first graph `s2` for the second graph, and so on
`grid on/off`	display the grid on the plot
`hold on/off`	switch between modes of adding or replacing plots

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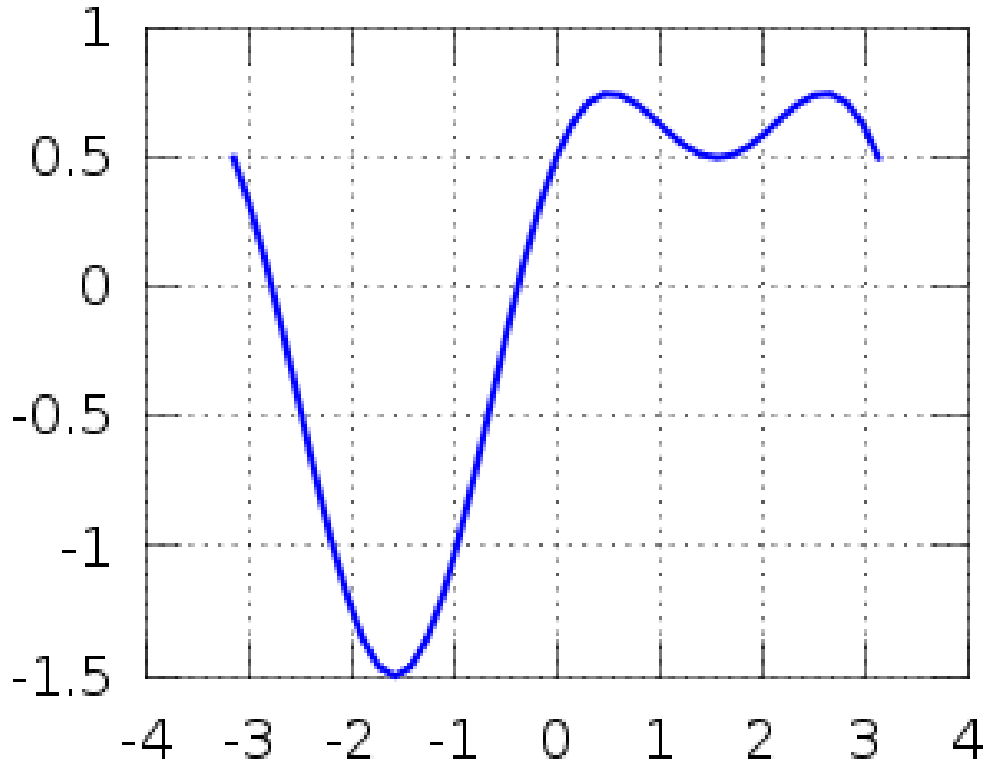
Plot annotations

```
x = [-pi:pi/20:pi];
z = sin(x)+cos(2*x)/2;
plot(x,z);
title('Plot of y(x)');
xlabel('x');
ylabel('y');
grid on;
print("rysunek8.png");
```



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Line types

Code	Line type	Code	Line colour
`'-'`	continuous (default)	`'y'`	yellow
`'--'`	dashed	`'m'`	magenta
`':'`	dotted	`'c'`	cyan
`'-.'`	dash-dot	`'r'`	red
		`'g'`	green
		`'b'`	blue
		`'w'`	white
		`'k'`	black

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Marker types

'+'	cross
'*'	star
'.'	dot
'o'	circle
'x'	x
's'	square
'd'	diamond
'p'	pentagram
'h'	hexagram
'v'	down-pointing triangle
'^'	up-pointing triangle
'<'	left-pointing triangle
'>'	right-pointing triangle

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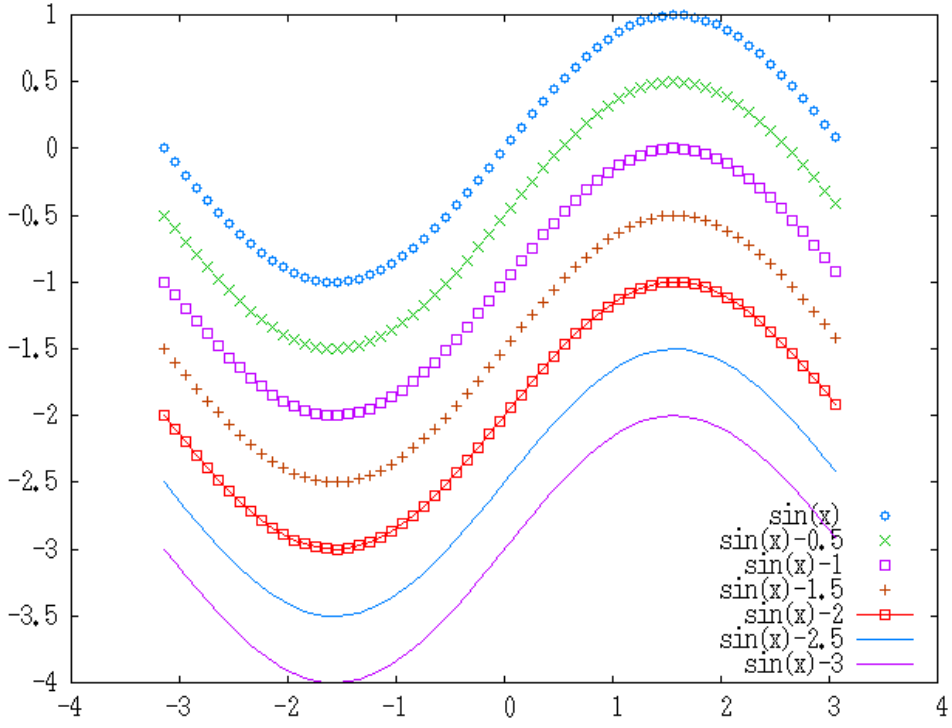
Marker types example

```
x = −pi:0.1:pi;
y1 = sin(x);
y2 = sin(x) − 0.5;
y3 = sin(x) − 1;
y4 = sin(x) − 1.5;
y5 = sin(x) − 2;
y6 = sin(x) − 2.5;
y7 = sin(x) − 3;
plot(x,y1,'b*'); hold on;
plot(x,y2,'g+'); hold on;
plot(x,y3,'mx'); hold on;
plot(x,y4,'ko'); hold on;
plot(x,y5,'rx−−'); hold on;
plot(x,y6,'b:'); hold on;
plot(x,y7,'m−.'); hold on;
legend('sin(x)','sin(x)−0.5',...
'sin(x)−1','sin(x)−1.5',...
'sin(x)−2','sin(x)−2.5',...
'sin(x)−3',4);
pause()
print('zadanie6.png');
```



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Axis limits for plots

Command	Description
`axis([xm xM ym yM])`	set axis limits
`axis auto`	set axis limits automatically
`axis ij`	y-axis pointing down
`axis xy`	y-axis pointing up
`axis equal`	force x distance to equal y-distance
`axis square`	force a square aspect ratio
`axis normal`	restore normal axes ratio
`axis off`	turn tic marks off for all axes
`axis on`	turn tic marks and labels on for all axes

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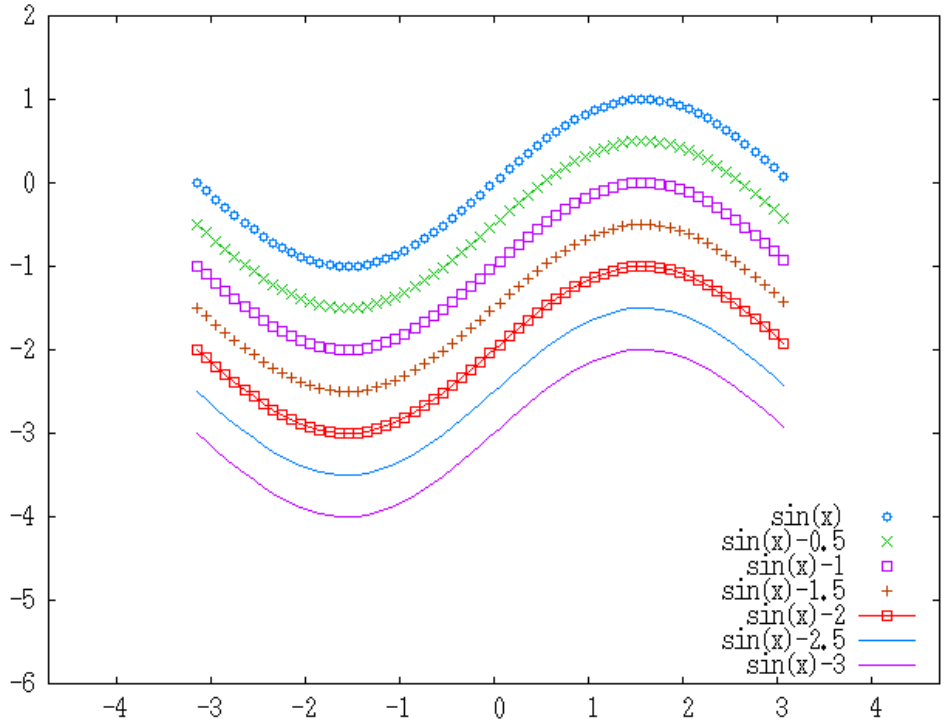
Example of setting axis limits

```
x = −pi:0.1:pi;
y1 = sin(x); y2 = sin(x) −0.5;
y3 = sin(x) −1; y4 = sin(x) −1.5;
y5 = sin(x) −2; y6 = sin(x) −2.5;
y7 = sin(x) −3;
plot(x,y1,'b∗'); hold on;
plot(x,y2,'g+'); hold on;
plot(x,y3,'mx'); hold on;
plot(x,y4,'ko'); hold on;
plot(x,y5,'rx−−'); hold on;
plot(x,y6,'b:'); hold on;
plot(x,y7,'m−.'); hold on;
legend('sin(x)','sin(x)−0.5',...
'sin(x)−1','sin(x)−1.5',...
'sin(x)−2','sin(x)−2.5','sin(x)−3',4);
axis([−3/2∗pi 3/2∗pi −6 2])
pause()
print('zadanie6a.png');
```



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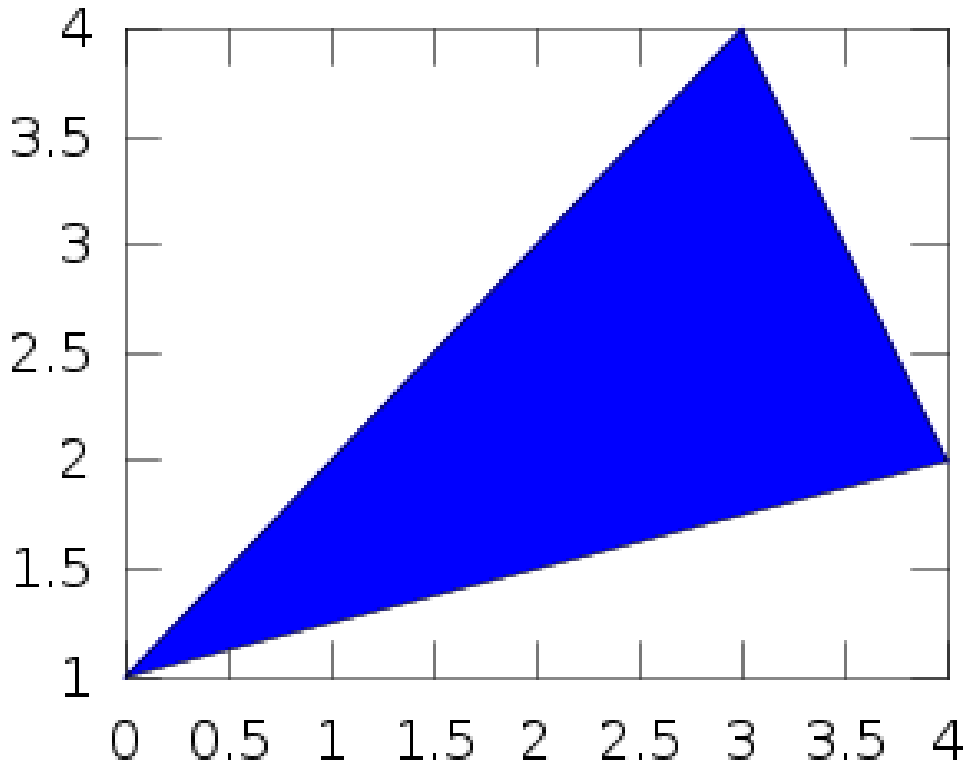
Plotting filled regions

```
clear
clc
disp("Task:");
disp("Draw triangle with vertices ...
at points (0,1),(3,4),(4,2)");
pause();
fill([0 3 4],[1 4 2],'b');
pause();
print("rysunek9.png");
```



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Subplots

Function `subplot`

- split plotting window into a grid of subwindows
- `subplot(m,n,p)` creates grid of `m x n` subwindows,
- subwindows are numbered from left to right, top down.
- `subplot(Position,[left bottom width height])`,
  places a subwinow in active window,
  `width` and `height` are the ratios of the whole figure.

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Example: plotting shapes

```
x_square = [−3 3 3 −3 −3]; y_square = [−3 −3 3 3 −3];
x_circle = 3∗cos([0:10:360]∗pi/180); y_circle = 3∗sin([0:10:360]∗pi/180);
x_triangle = 3∗cos([90 210 330 90]∗pi/180); y_triangle = 3∗sin([90 210 330 90]∗pi/180);
subplot(2,2,1)
plot(x_circle,y_circle,'−−g','LineWidth',3); axis([−4 4 −4 4]); axis('equal');
title('Circle');
subplot(2,2,2)
plot(x_square,y_square,'−r','LineWidth',3); axis([−4 4 −4 4]);
axis('equal');
title('Square');
subplot(2,2,3)
plot(x_triangle,y_triangle,':b','LineWidth',3); axis([−4 4 −4 4]);
axis('equal');
title('Triangle');
subplot(2,2,4)
plot(x_square,y_square,'−r','LineWidth',3);
hold on;
plot(x_circle,y_circle,'−−g','LineWidth',3);
plot(x_triangle,y_triangle,':b','LineWidth',3);
axis([−4 4 −4 4]); axis('equal');
title('Combination Plot');
pause()
print("zadanie18.png")
```

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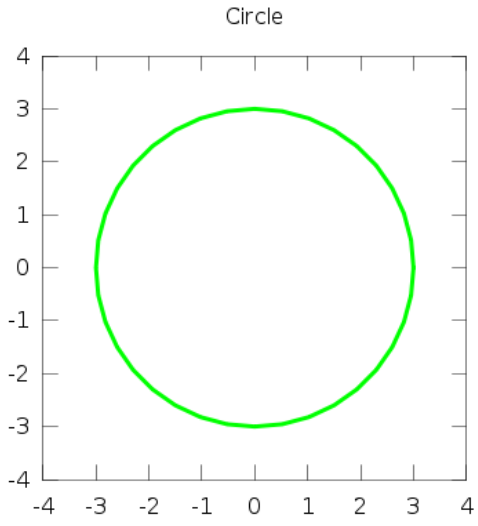
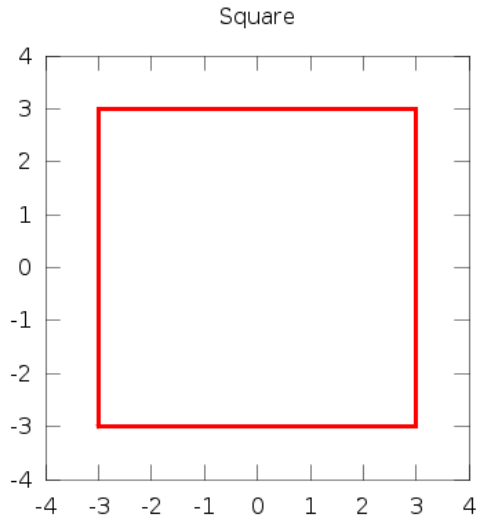
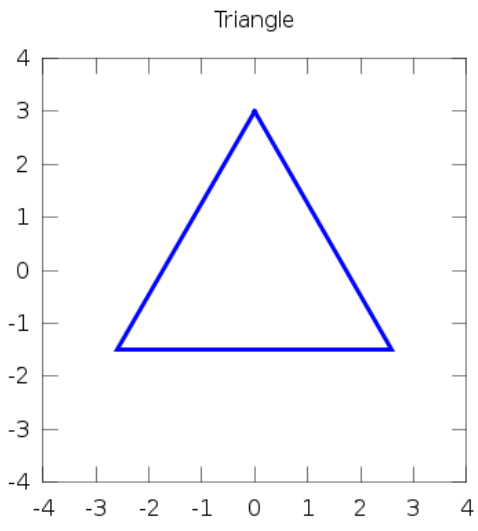
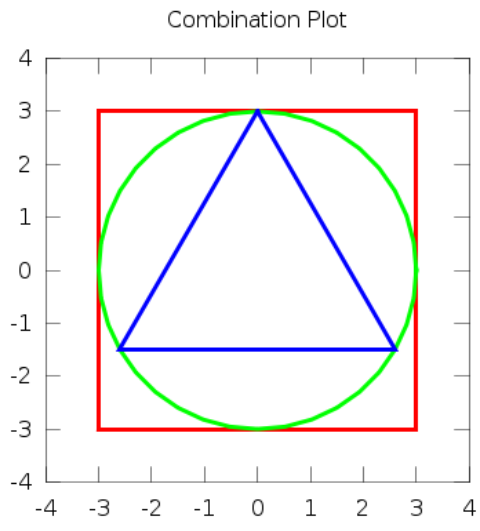
Example: plotting shapes









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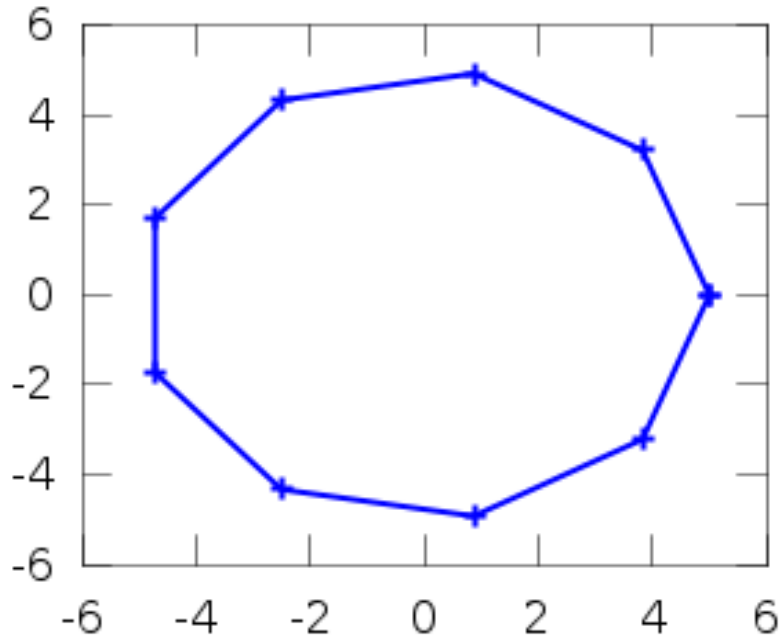
Example – plotting regular polygon

Plotting regular N-gon inscribed in a circle of radius R. Vertices coordinates:

$$x_i = R\cos(\frac{2\pi(i-1)}{N}) \qquad y_i = R\sin(\frac{2\pi(i-1)}{N})$$

where $i = 1, \cdots, N$.

```
N = input('Number of sides N =');
R = input('Circle radius R =');
beta = 2*pi/N;
for i = 1:N+1
  x(i) = R*cos(beta*(i-1));
  y(i) = R*sin(beta*(i-1));
endfor
axis('square');
plot(x,y,"@-","linewidth",4);
pause()
print("wielo.png");
```



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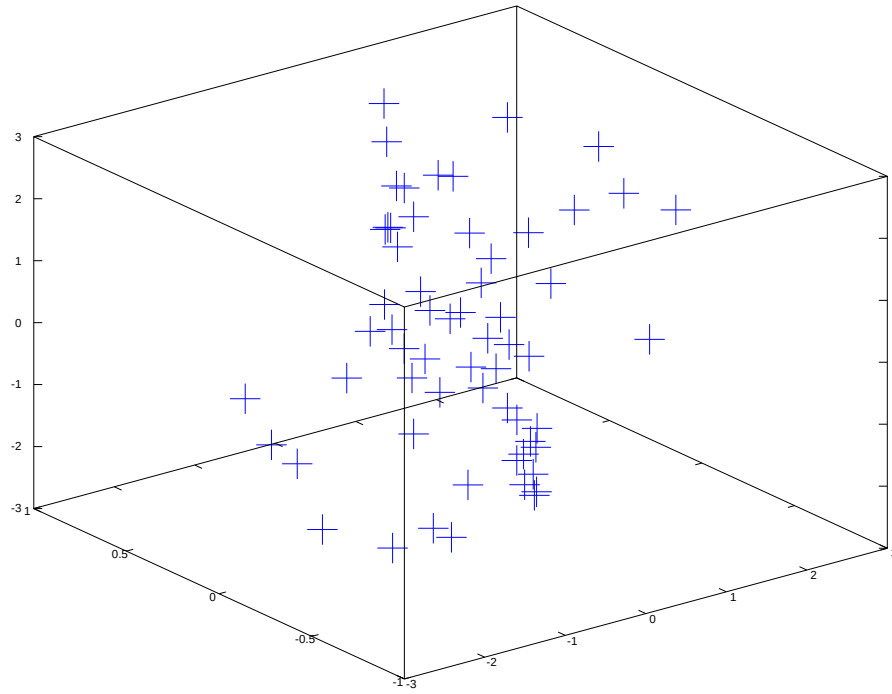
Function plot3

```
x= −3:.1:3;
y= sin(x);
size(x)
z= randn(1,61);
plot3(x,y,z,"b+","MarkerSize",20);
pause()
print("Plot3.png");
```



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Function meshgrid

This function generates matrices that describe 2D or 3D mesh taking as the arguments vectors that discretise ranges of X,Y (and Z for 3D).

`[xx,yy]=meshgrid(X,Y)` When returning only 2 arguments, return matrices corresponding to the `X` and `Y` coordinates of a mesh. The rows of `xx` are copies of `X`, and the columns of `YY` are copies of `Y`.

`[x,y]=meshgrid(X)` equivalent to calling `meshgrid(X,X)`.

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Function mesh

- `mesh(x,y,z,c)` plot surface grid described by matrices x,y,z where value c specifies colour of grid vertices.
- `mesh(x,y,z)` as above assuming $c = z$.
  `mesh(z,c)` plot surface grid assuming `x = 1:n, y = 1:m, [m,n] = size(z)`.
- `meshc(x,y,z,c)` plot surface grid and its contour lines the same time.

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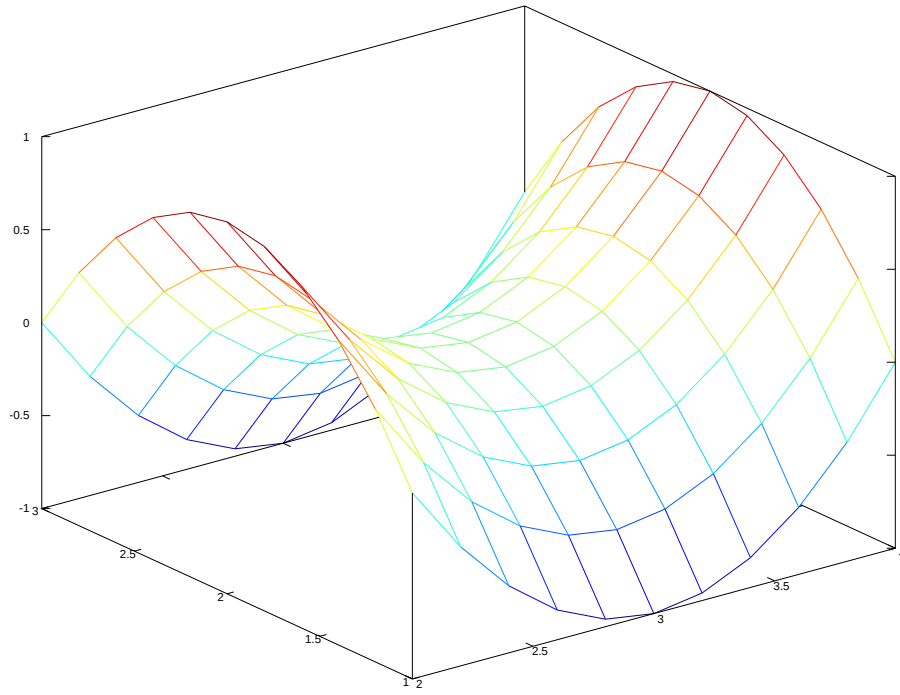
Example of using function mesh

```
x = 2: 0.2: 4;
y = 1: 0.2: 3;
[xx,yy] = meshgrid(x,y);
z = (xx−3).^2 − (yy−2).^2;
mesh(x,y,z)
pause()
print("zadanie5.png");
```



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Function figure

- if necessary Octave can plot in separate graphics windows
- `figure(1)` creates a window with id '1',
- `figure(3)` creates a window with id '3',
- regardless of the number of opened windows the plotting operations take place only in the last opened window.

Example:

```
t=0:.1:2*pi;
figure(1); plot(t,sin(t));
figure(2); plot(t,cos(t));
figure(1); plot(t,sin(2*t));
```

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Example of using function mesh and figure

```
disp('Function values ');
disp('f(x,y) = sin(x)sin(y)exp(-x^2-y^2) in range
[-pi,pi]');
[x,y] = meshgrid(-pi:0.2:pi,-pi:0.2:pi);
z = sin(x).*sin(y).*exp(-x.^2-y.^2);

figure(1)
mesh(x,y,z);
pause()

% or
figure(2)
surf(x,y,z)
pause()
```

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Function surf

- `surf(x,y,z,c)` plot surface described by matrices x,y,z,
- `surf(x,y,z)` plot surface assuming c=z,
- `surf(z,c)` plot surface assuming `x=1:n`, `y=1:m`, `[x,y]=size(z)`,
- `surfc(x,y,z,c)` plot surface and its contours,
- `surfl(x,y,z,s,k)` plot lighted surface, The light direction can be specified using argument s. Surface properties like diffusivity and reflexivity can be given in argument k.

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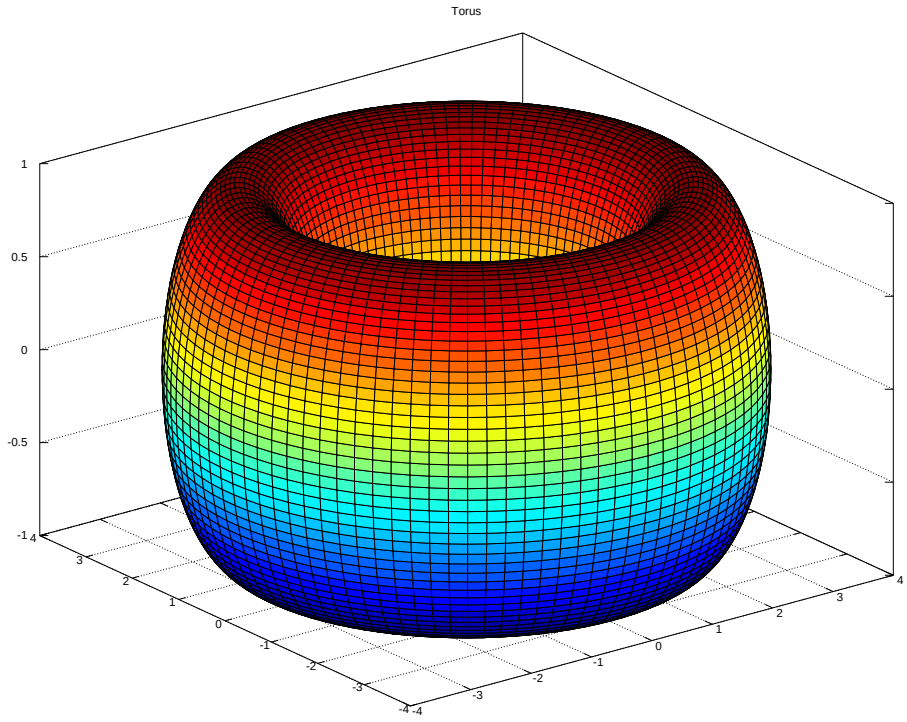
Example of using function surf

```
[phi,theta] = ...
meshgrid(linspace(0,2*pi,100));
x =(cos(phi) + 3).* cos(theta);
y =(cos(phi) + 3).* sin(theta);
z =sin(phi);
c =sin(3*theta);

surf(x,y,z)
title('Torus');
pause();
print("torus.png");
```



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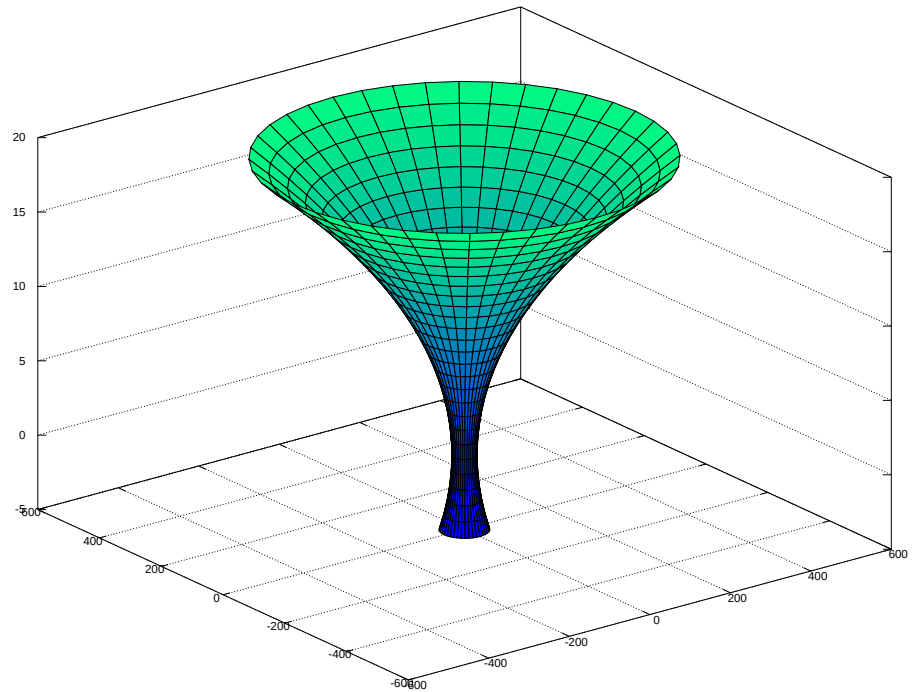
Example of using function `surf`

Plotting surface of revolution.

```
theta= pi*(-20:20)/20;
h=(-5:20)';
X= (25+h.^2)*sin(theta);
Y= (25+h.^2)*cos(theta);
Z= h*ones(1,41);
colormap winter
# available colormaps
# bone, cool, copper, gray, hot, hsv,
# jet, ocean, pink, prism, rainbow,
# spring, summer, white, winter
surf(X,Y,Z)
print("RRys1.ps")
```



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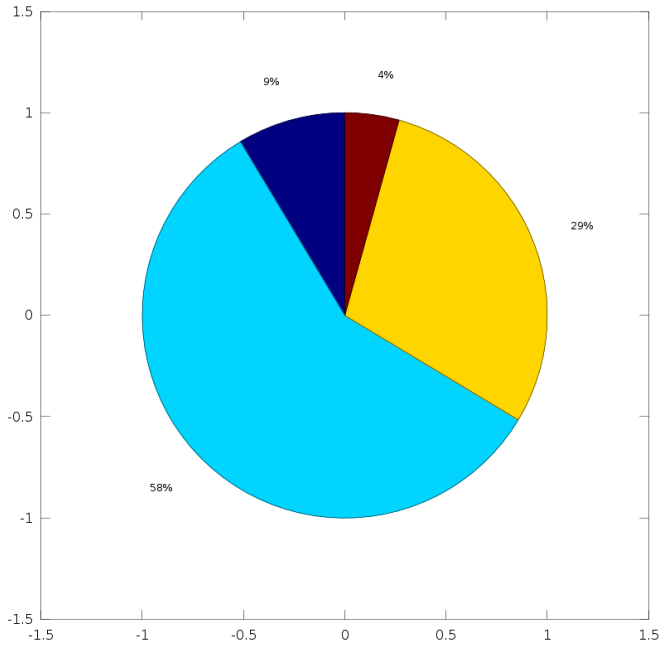
Pie plot

```
printf("\t\t Pie plot\n");
title("Pie plot");
axis "off"
pie([10 67 34 5])
print("wykreskolowy.png");
```



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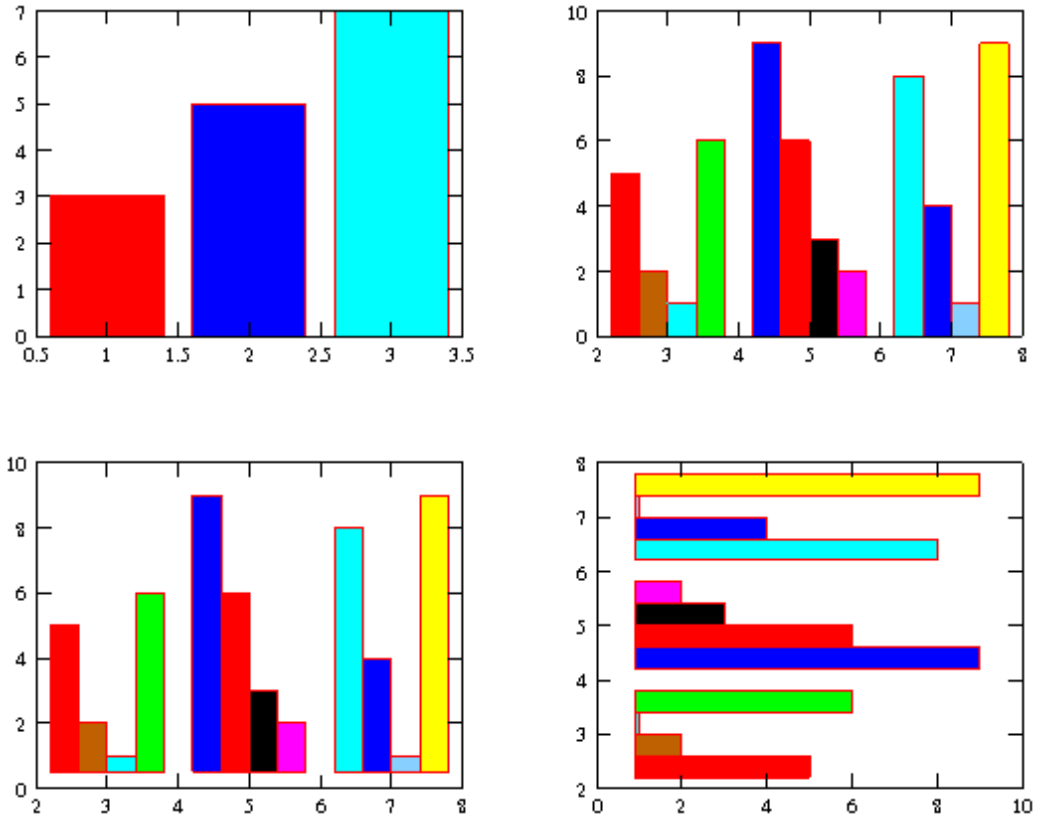
Bar plot

```
% Bar plots

subplot(221)
b= [3 5 7]; bar(b);
subplot(222)
y= [5 2 1 6; 9 6 3 2; 8 4 1 9];
bar(b,y);
subplot(223)
bar(b,y,'basevalue',0.5);
subplot(224)
barh(b,y,'basevalue',0.9)
print("wykres_s.png");
```



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