MATLAB

2D graphics

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Let's go back to when we first learned the graph of the function $y = f(x)$ on $a \leq x \leq b$.

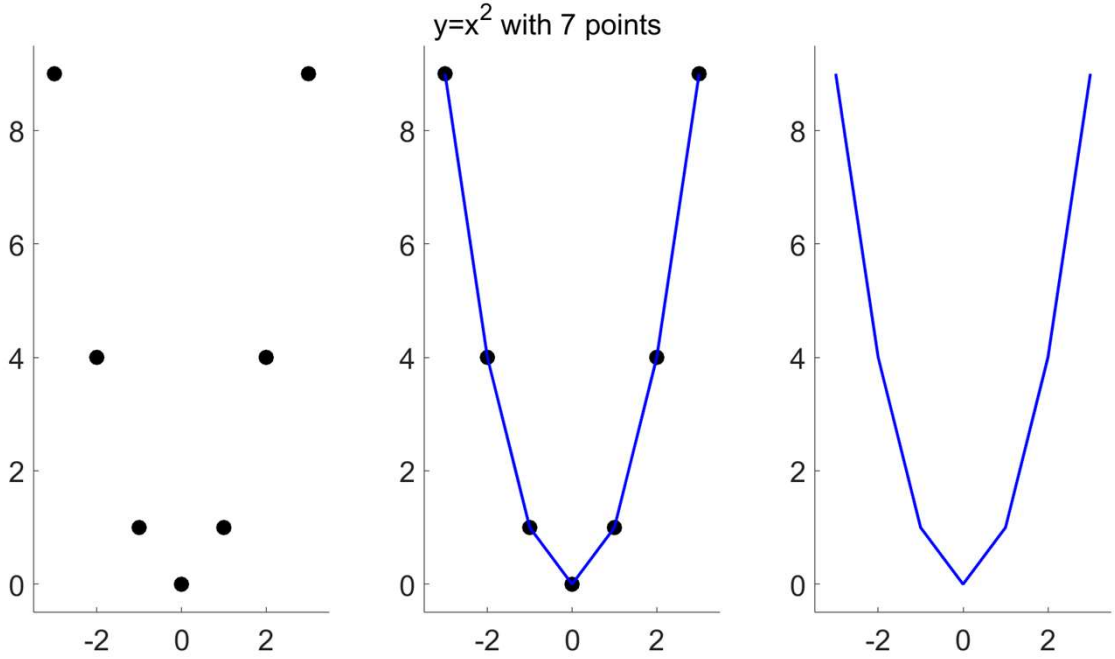
For example, we will draw the graph $y = x^2$ on $-3 \leq x \leq 3$.

We make a table

x	-3	-2	-1	0	1	2	3
y	9	4	1	0	1	4	9

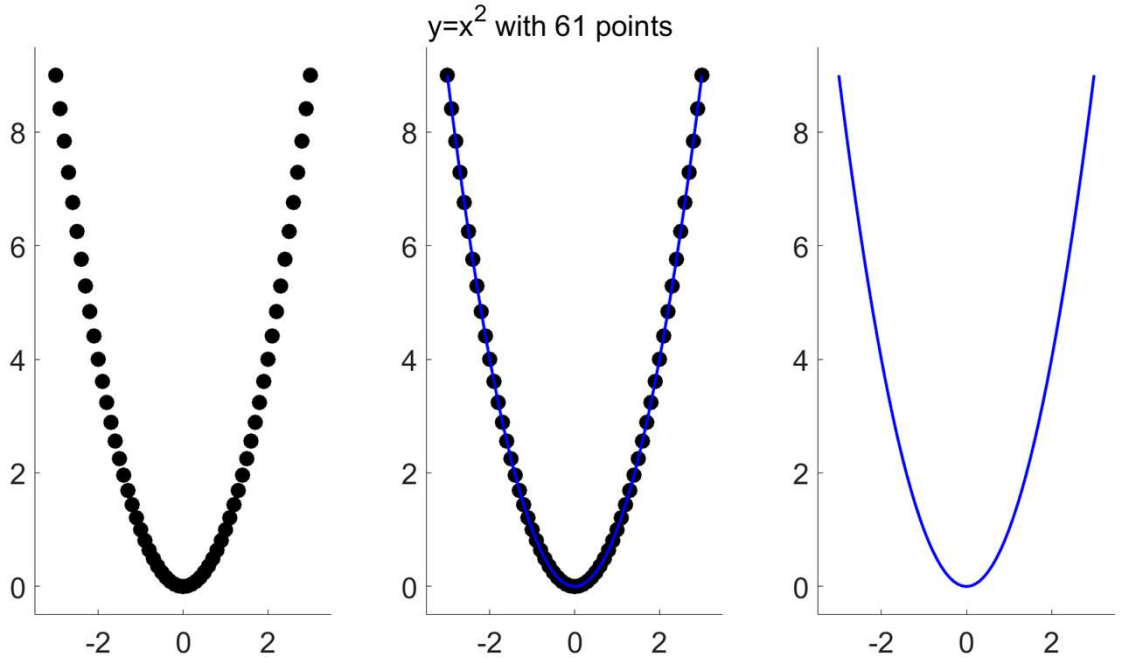
and dot the points on xy plain.

And then connect dots with lines.



The more points you use, the better the graph

x	-3	-2.9	-2.8	⋯	0	⋯	2.8	2.9	3
y	9	8.41	7.84	⋯	0	⋯	7.84	8.41	9



This is the basic idea of drawing a graph.

To draw the graph of the function $y = f(x)$ on $a \leq x \leq b$.

1. Make the domain points.
   - There are 2 ways.
   1) "$x =$ linespace(a, b, N)" : $a = x_1 < x_2 < \cdots < x_{N-1} < x_N = b$ with evenly spaced.
   2) "$x =$ "$a{:}\, h{:}\, b$ " : $a = x_1 < x_1 + h < \cdots < x_{end} - h < x_{end} \leq b$

2. Compute the $y = f(x)$ on the domain points.
   - see the next slide.

3. Connect the dots with lines.
   - "scatter(x, y)" : dot the points
   - "plot(x, y)" : connect the points with lines.

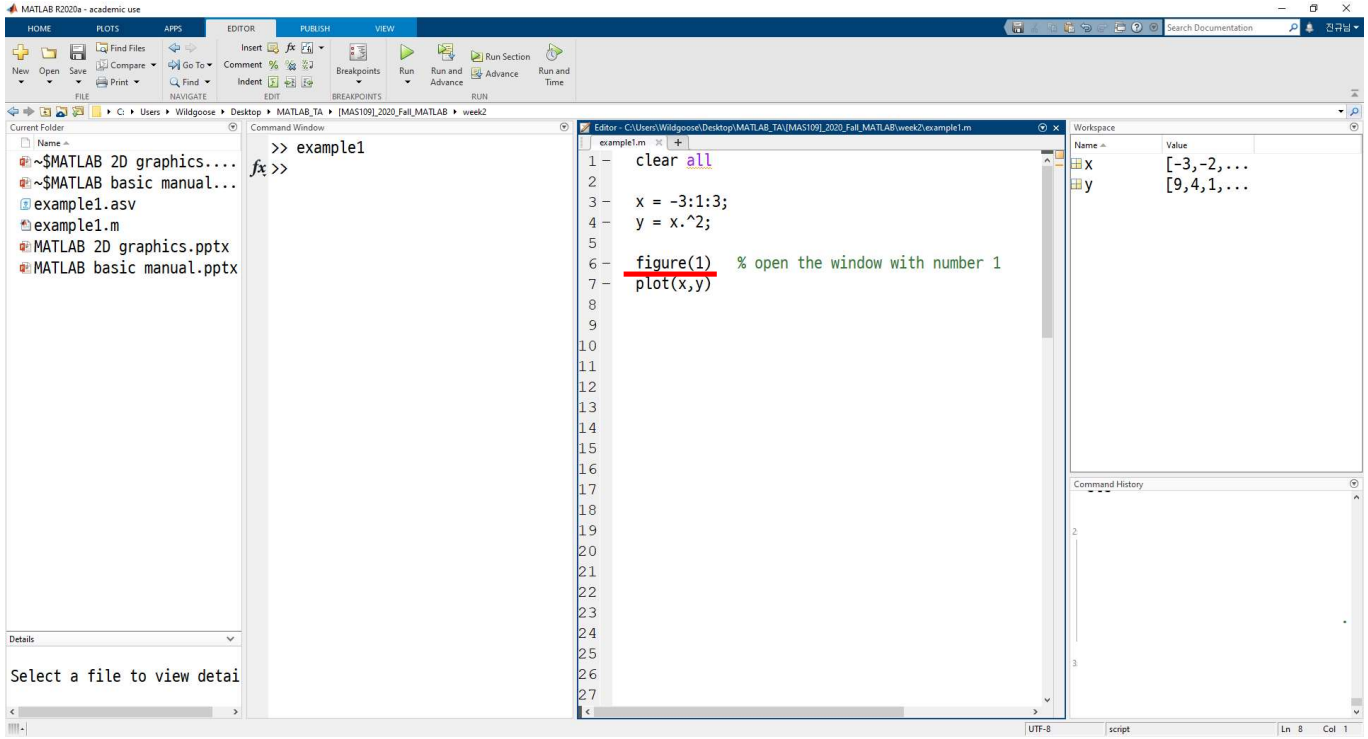
Compute the $y = f(x)$ on the domain points.

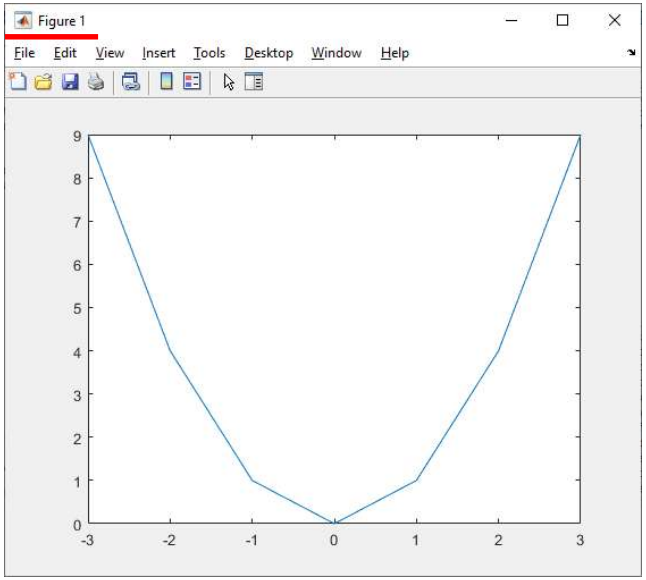
Here x is the vector which represents the domain points. (ex. $x = [-3, -2, -1, 0, 1, 2, 3]$)
Key idea for vector element-wise operation is just put . before the operation.

$\mathbf{y} = f(x)$	MATLAB code	
x^d	x.^d	
a^x	a.^x	
e^x	exp(x)	$e = \exp(1)$
$\log_e x$	log(x)	
$\sin(x), \cos(x), \tan(x)$	$\sin(x), \cos(x), \tan(x)$	
$\lvert x \rvert$	abs(x)	
$\sqrt{x}$	sqrt(x) or x.^(0.5)	
$\frac{1}{x}$	1./x	
$\left\lvert \frac{x^2 - 2^x}{\log(x)} \right\rvert$	abs((x.^2-2.^x) ./ log(x))	Example.

Now we have 2 vectors x, y. To see the graph, we will open the window.

MATLAB command "figure()" make a black window.
Use "plot(x, y)" or "scatter(x, y)" to see the data in xy plain.





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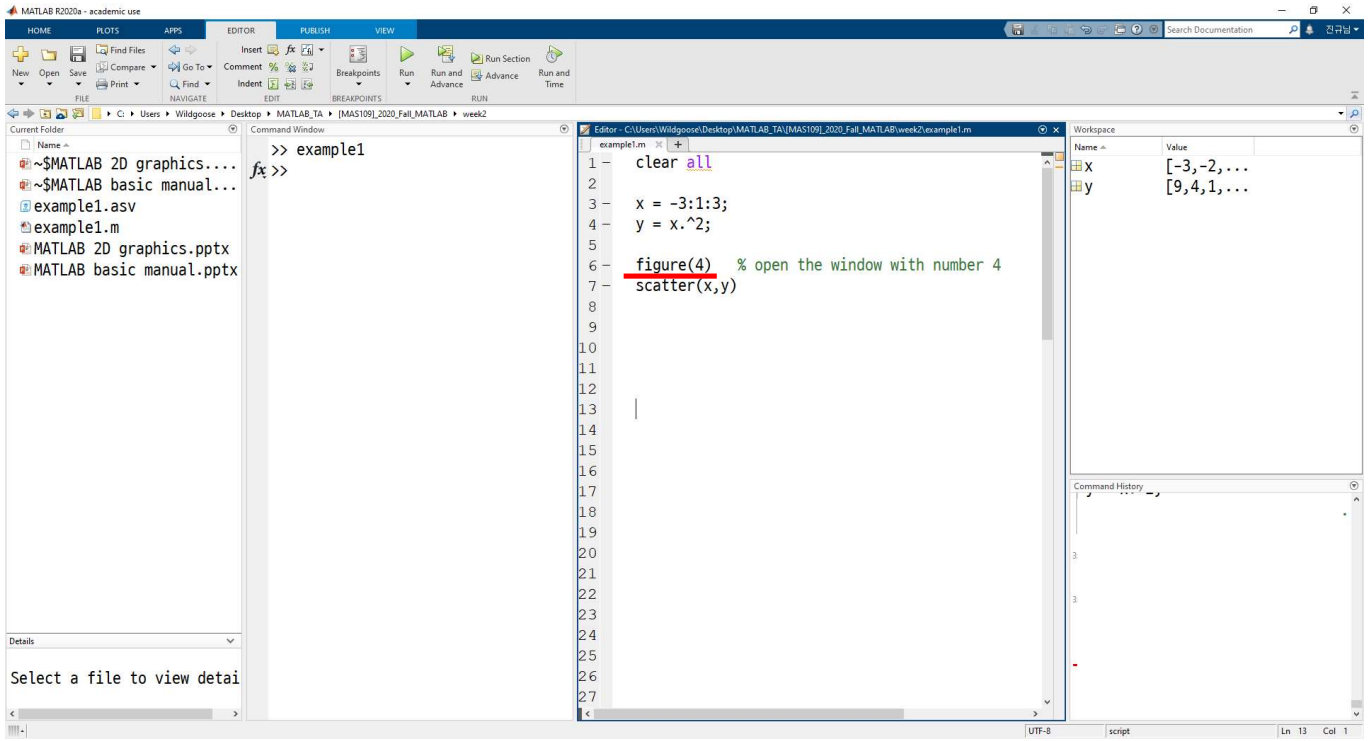
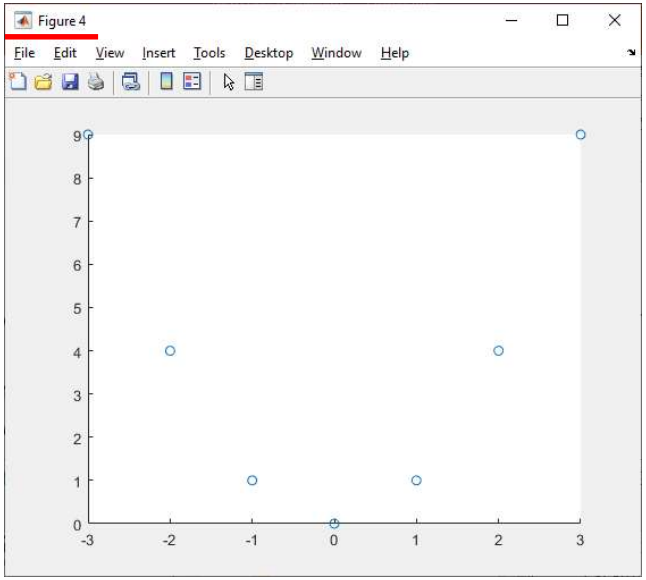




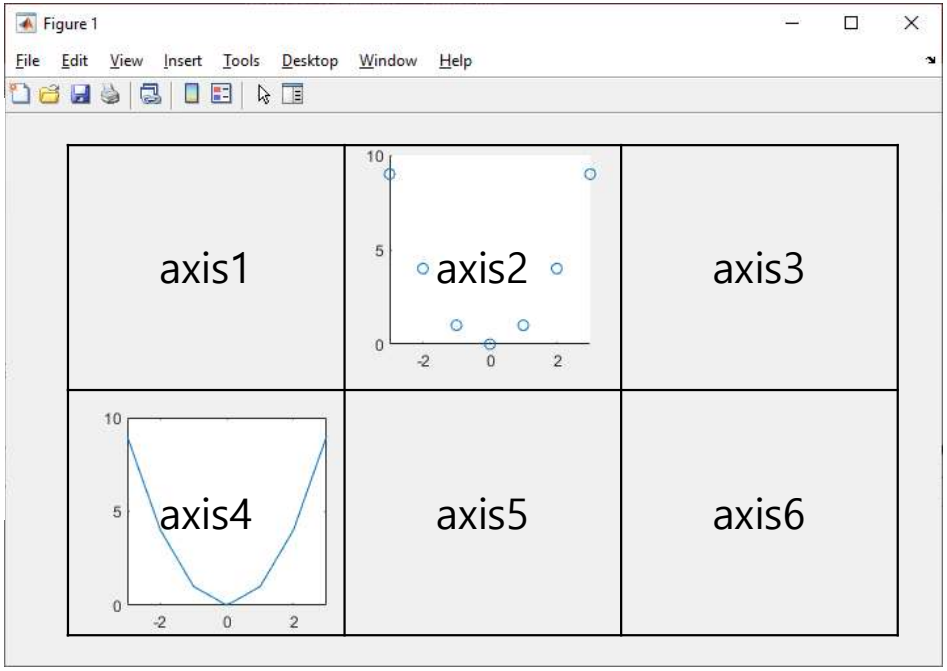
Display the several plots in same "figure" window.

MATLAB command "subplot(m, n, k)" : divide the figure window into $m \times n$ regions and select the k^{th} region. So $1 \leq k \leq mn$. For example, consider "subplot$(2,3, k)$"

```
clear all

x = -3:1:3;
y = x.^2;

figure(1)   % open the window with number 1
subplot(2,3,2),scatter(x,y)
subplot(2,3,4),plot(x,y)
```



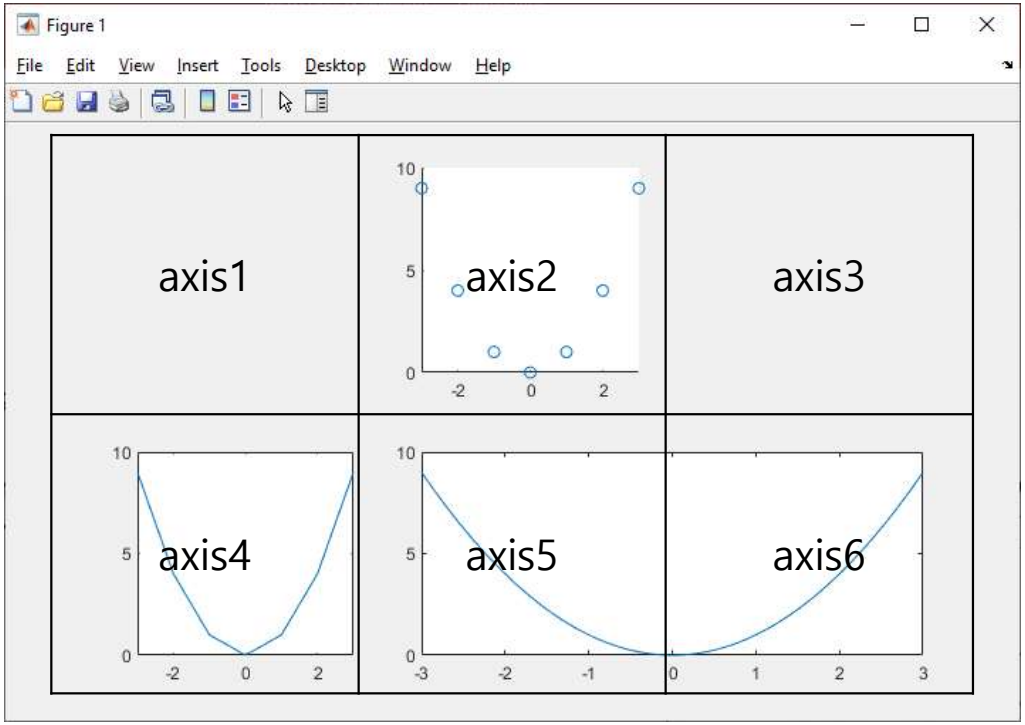
If you want to draw the graph in double size in 5, 6 axes simultaneously.
Then use the "subplot(2,3,[5,6])"

```
clear all

x = -3:1:3;
y = x.^2;

figure(1)   % open the window with number 1
subplot(2,3,2),scatter(x,y)
subplot(2,3,4),plot(x,y)

x = -3:0.1:3;
y = x.^2;
subplot(2,3,[5,6]),plot(x,y)
```



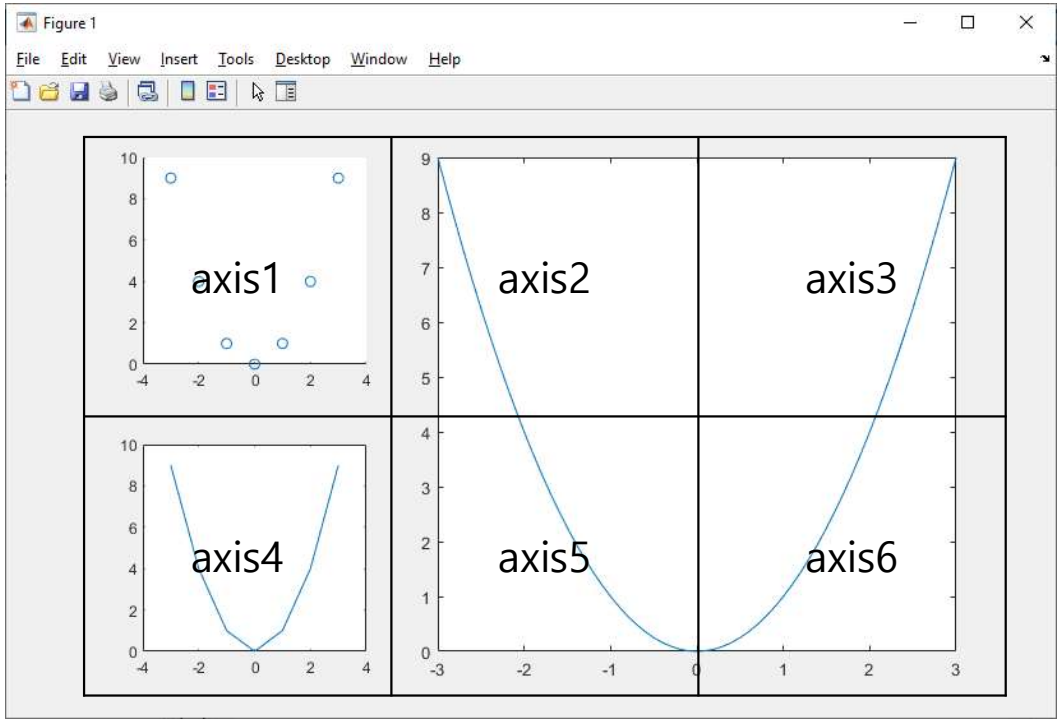
Or you can draw in 2,3,5,6 axes simultaneously by use the “subplot(2,3,[2,3,5,6])”

```
clear all

x = -3:1:3;
y = x.^2;

figure(1) % open the window with number 1
subplot(2,3,1),scatter(x,y)
subplot(2,3,4),plot(x,y)

x = -3:0.1:3;
y = x.^2;
subplot(2,3,[2,3,5,6]),plot(x,y)
```

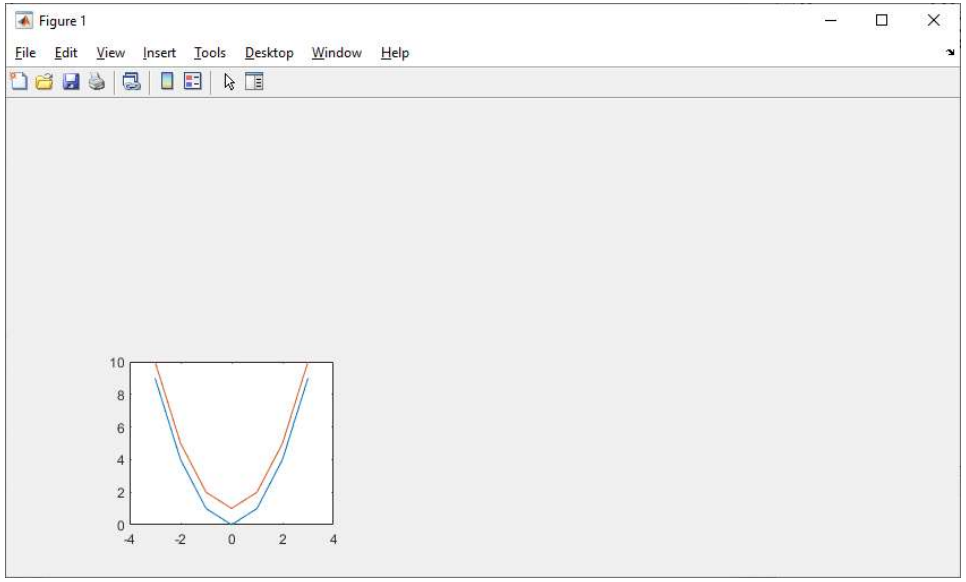


MATLAB can draw the multiple graph in same axis.
Use the MATLAB command "hold on" and "hold off".

"hold on" : hold current axis and overlap the graphs.
"hold off" : end of "hold on"

```
clear all

x = -3:1:3;
y = x.^2;
z = x.^2 +1;
figure(1)   % open the window with number 1
subplot(2,3,4),plot(x,y)
hold on
plot(x,z)
hold off
```



MATLAB can draw the polar coordinate system.

Here is example. $r = \frac{\cos(\theta)}{2+\sin(\theta)}$ on $0 \leq \theta \leq 2\pi$

```
clear all

theta = linspace(0,2*pi,200);
r = cos(theta)./(2 + sin(theta));

figure(1)
polarplot(theta,r)
```