第一讲: MatLab 基础

数学模型和算法的应用与 MATLAB 实现

周吕文

中国科学院力学研究所

2017 年 6 月 11 日

微信公众号: 超级数学建模

Part I

MatLab 快速入门

简介

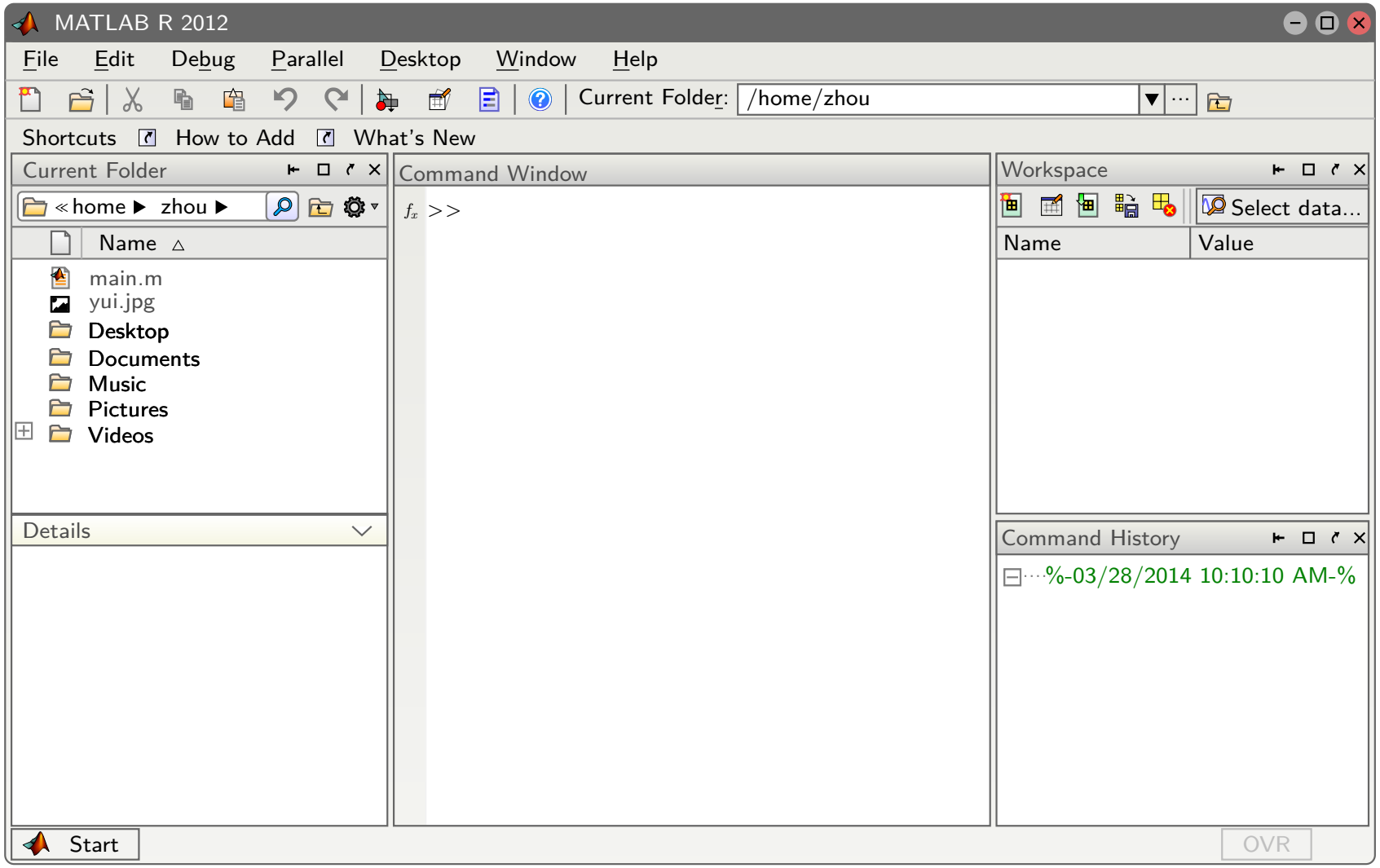
简史

- MATLAB (矩阵实验室) 是 **MAT**rix **LAB**oratory 的缩写;
- 最初由美国的 Clever Moler 教授于 1980 年开发, 初衷是为了解决“线性代数”课程的矩阵运算问题;
- 是一款由 MathWorks 公司 (1984 年成立) 出品的数学软件.

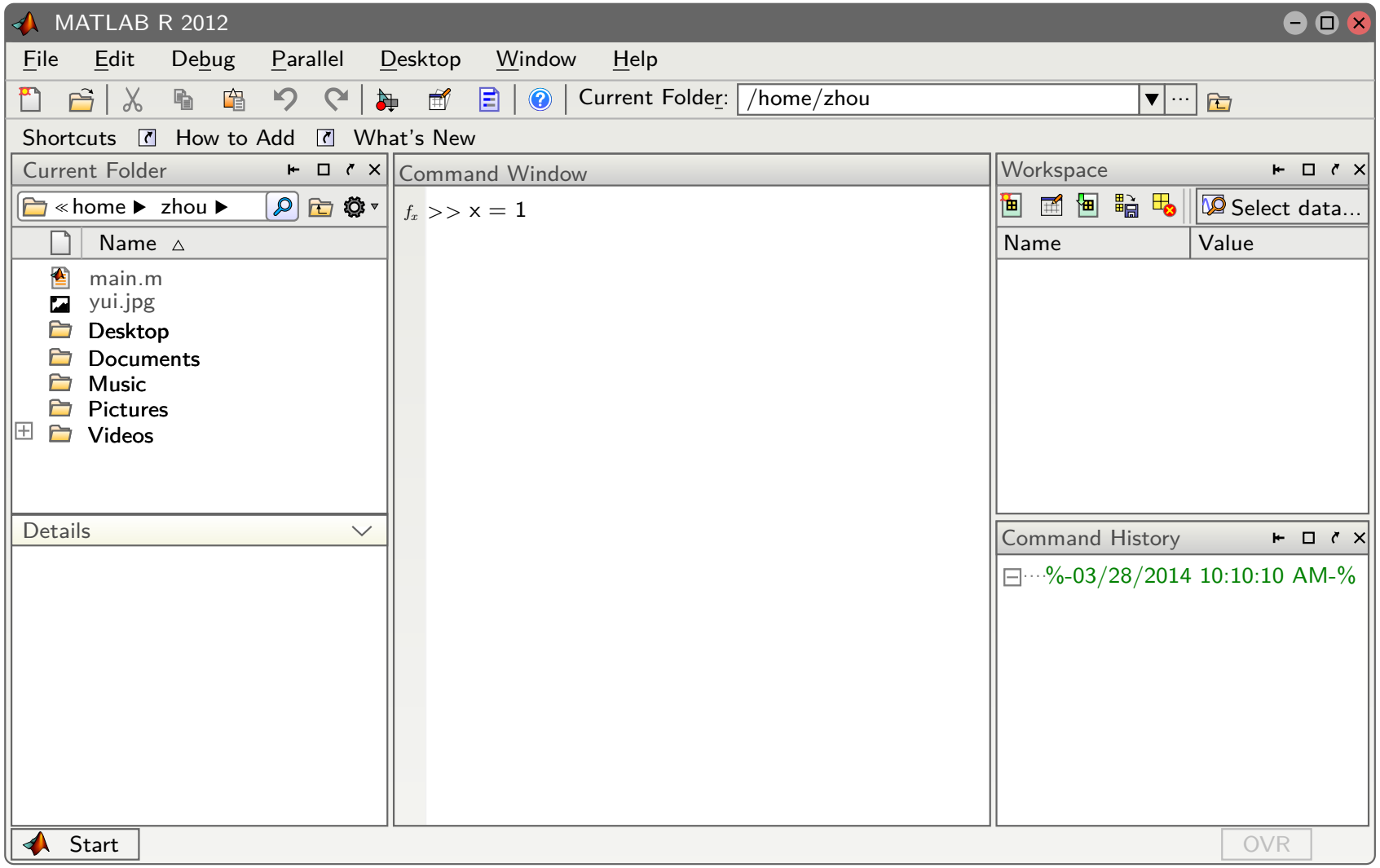
特性

- MATLAB 是一种用于算法开发, 数据可视化, 数据分析以及数值计算的高级技术计算语言和交互式环境.
- MATLAB 可用来创建用户界面及调用其它语言编写的程序.
- MATLAB 中包含众多的附加工具箱, 适合不同领域的应用.

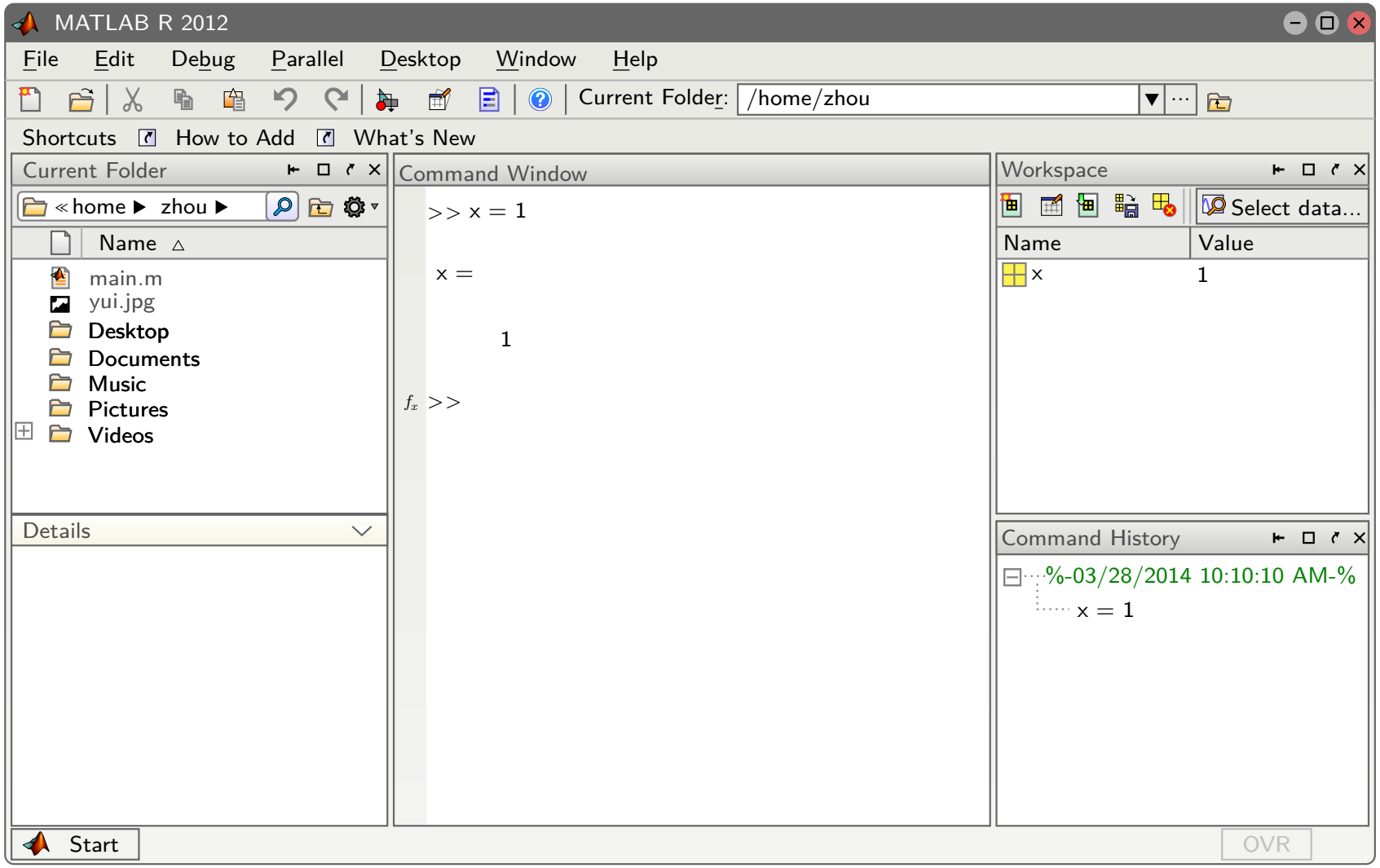
主窗介绍


MATLAB R 2012
File Edit Debug Parallel Desktop Window Help
Current Folder: /home/zhou
Shortcuts How to Add What's New
Current Folder
« home ▶ zhou ▶
Name
main.m
yui.jpg
Desktop
Documents
Music
Pictures
Videos
Details
Command Window
>>
Workspace
Select data...
Name
Value
Command History
%-03/28/2014 10:10:10 AM-%
Start
OVR

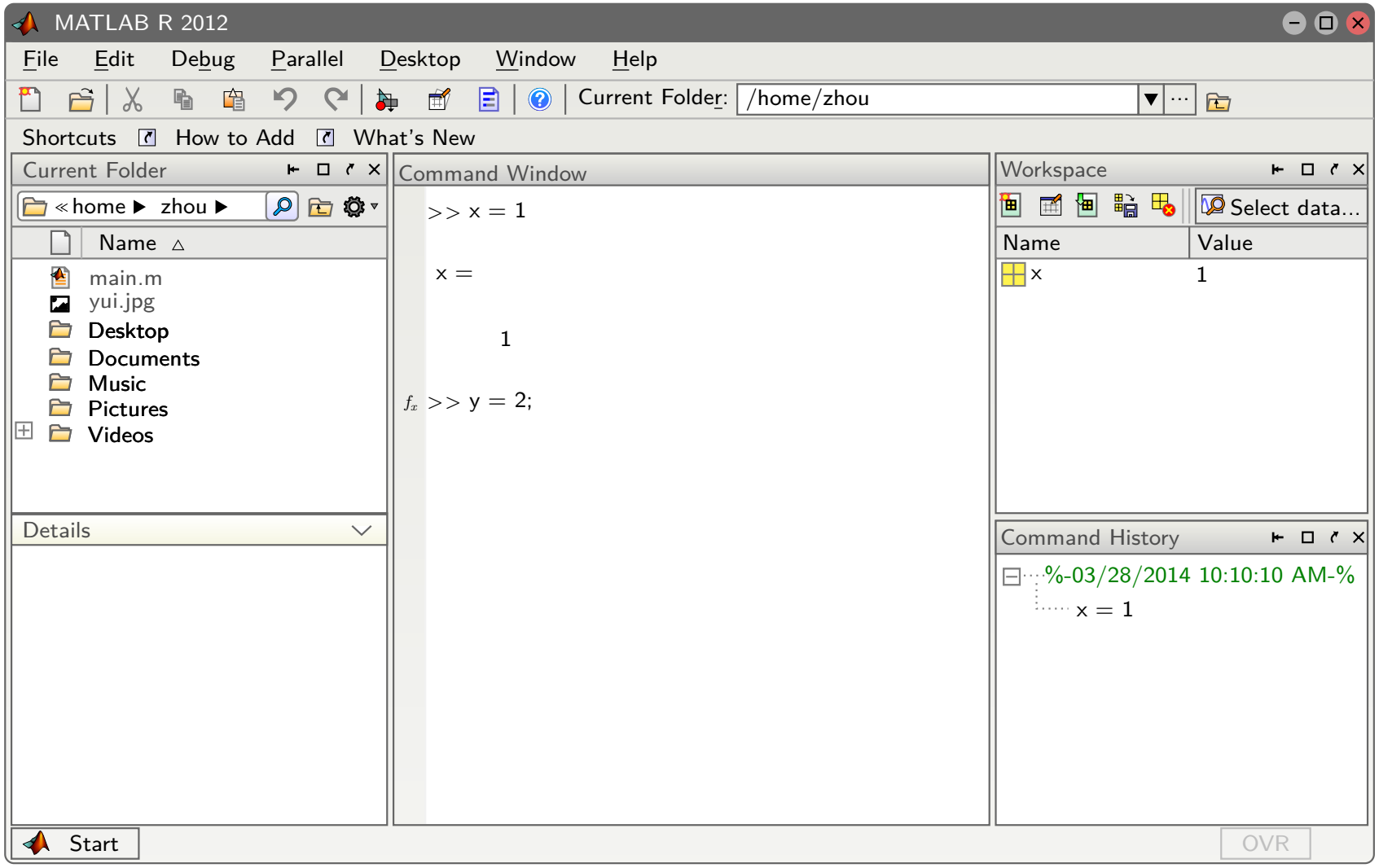
主窗介绍


MATLAB R 2012
File Edit Debug Parallel Desktop Window Help
Current Folder: /home/zhou
Shortcuts How to Add What's New
Current Folder
« home ▶ zhou ▶
Name
main.m
yui.jpg
Desktop
Documents
Music
Pictures
Videos
Details
Command Window
>> x = 1
Workspace
Select data...
Name
Value
Command History
%-03/28/2014 10:10:10 AM-%
Start
OVR

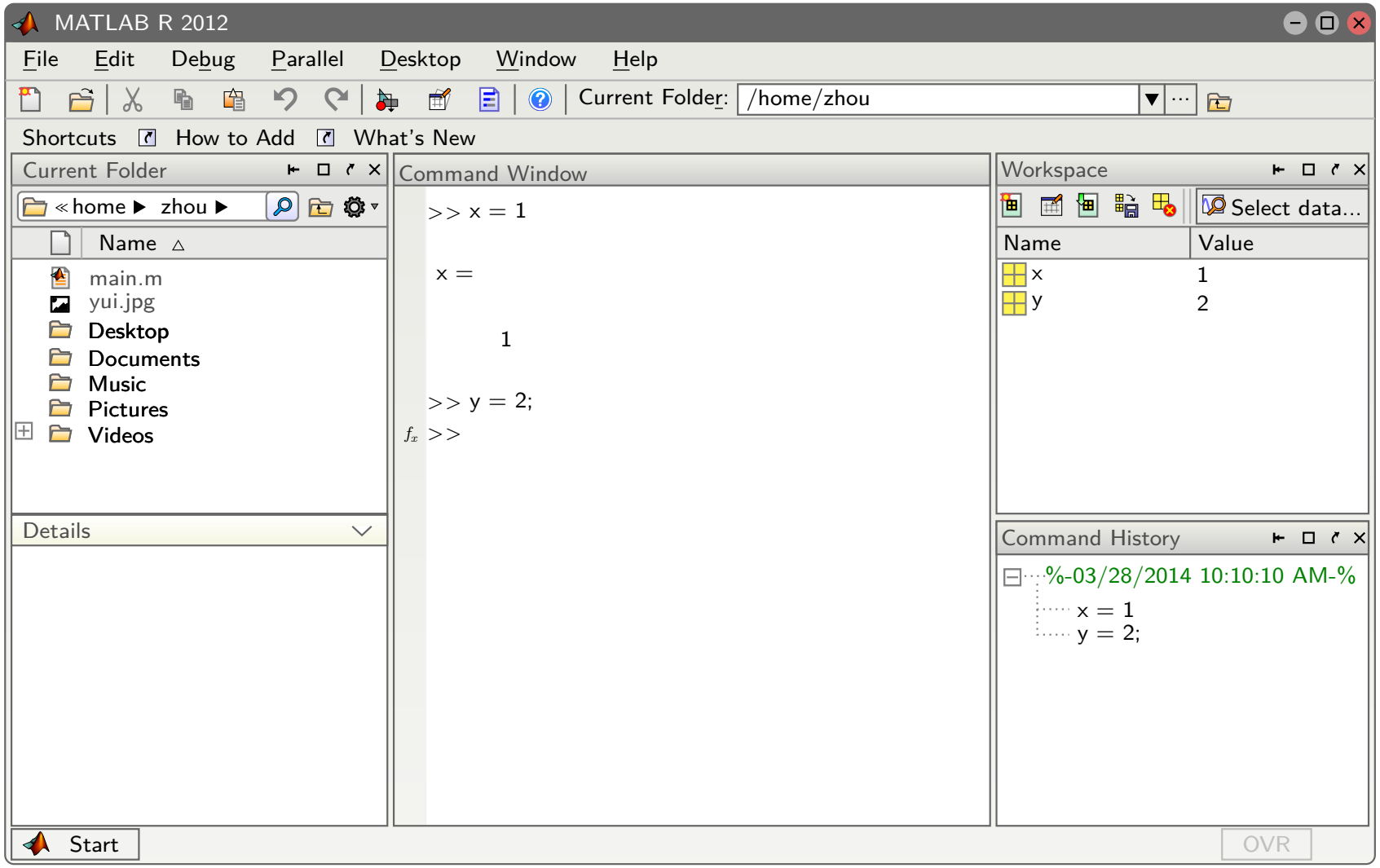
主窗介绍


MATLAB R 2012
File Edit Debug Parallel Desktop Window Help
Current Folder: /home/zhou
Shortcuts How to Add What's New
Current Folder
« home ▶ zhou ▶
Name
main.m
yui.jpg
Desktop
Documents
Music
Pictures
Videos
Details
Command Window
>> x = 1
x =
1
>>
Workspace
Select data...
Name
Value
x
1
Command History
%-03/28/2014 10:10:10 AM-%
x = 1
Start
OVR

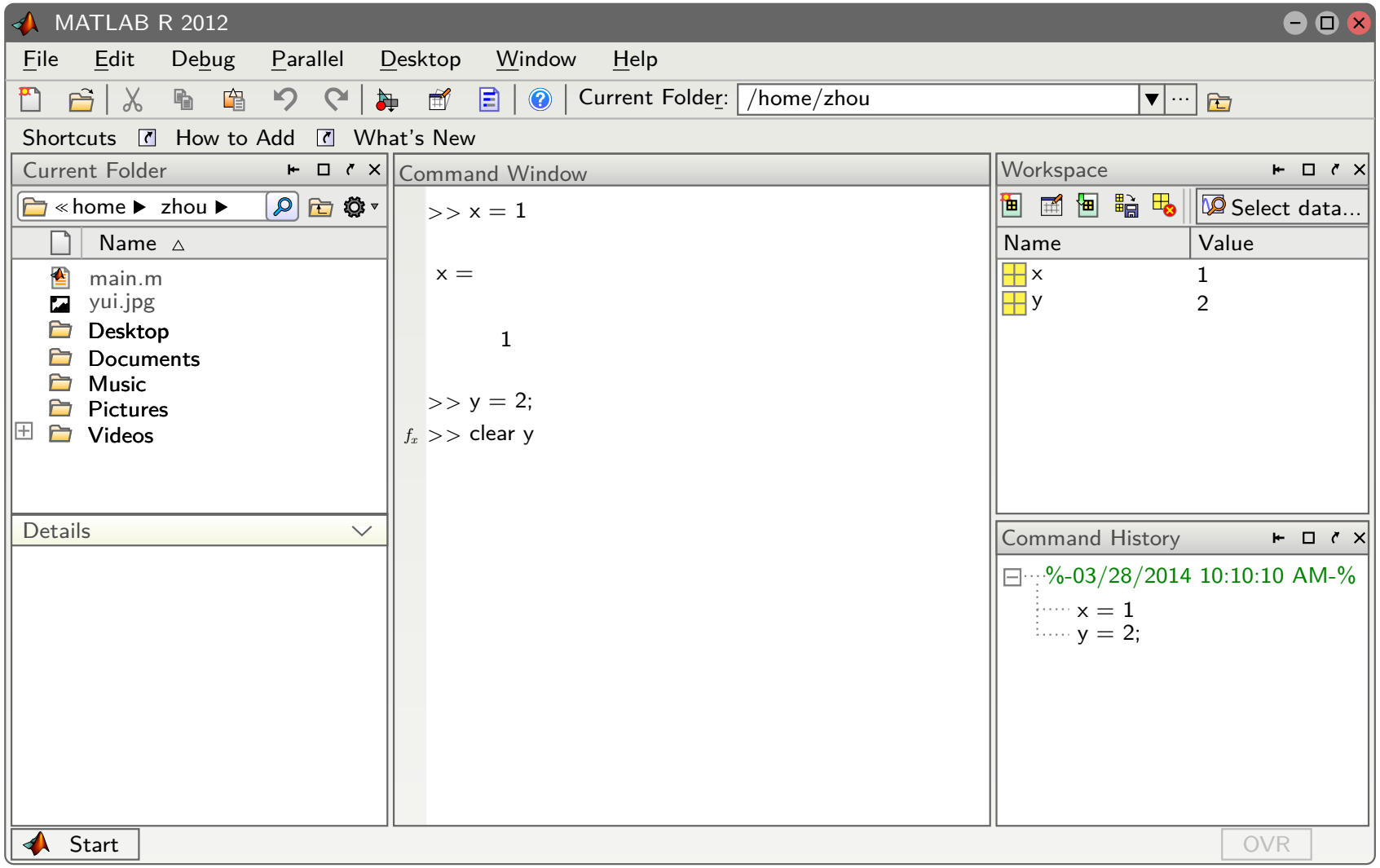
主窗介绍


MATLAB R 2012
File Edit Debug Parallel Desktop Window Help
Current Folder: /home/zhou
Shortcuts How to Add What's New
Current Folder
« home ▶ zhou ▶
Name
main.m
yui.jpg
Desktop
Documents
Music
Pictures
Videos
Details
Command Window
>> x = 1
x =
1
>> y = 2;
Workspace
Select data...
Name
Value
x
1
Command History
%-03/28/2014 10:10:10 AM-%
x = 1
Start
OVR

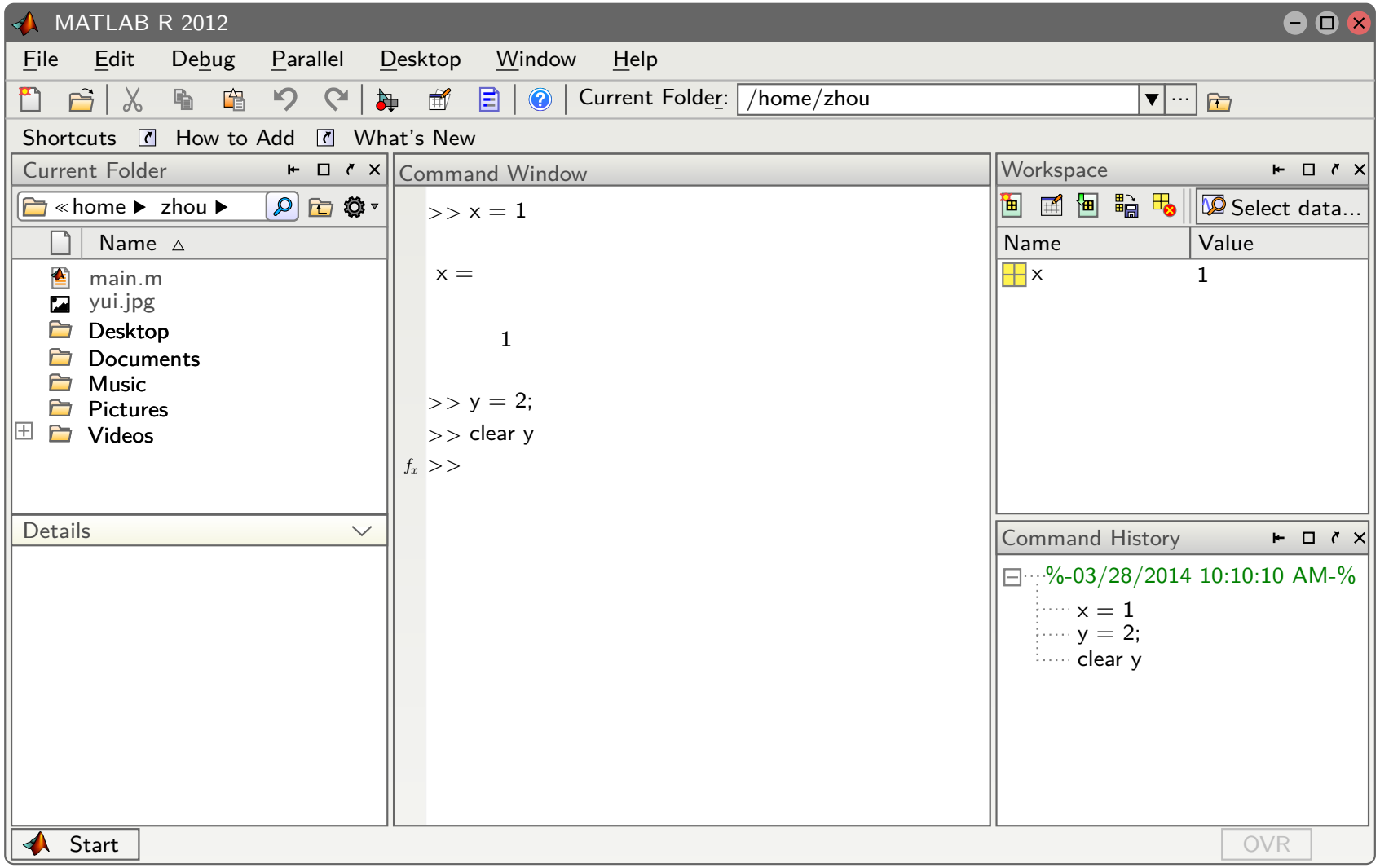
主窗介绍


MATLAB R 2012
File Edit Debug Parallel Desktop Window Help
Current Folder: /home/zhou
Shortcuts How to Add What's New
Current Folder
« home ▶ zhou ▶
Name
main.m
yui.jpg
Desktop
Documents
Music
Pictures
Videos
Details
Command Window
>> x = 1
x =
1
>> y = 2;
>>
Workspace
Select data...
Name
Value
x 1
y 2
Command History
%-03/28/2014 10:10:10 AM-%
x = 1
y = 2;
Start
OVR

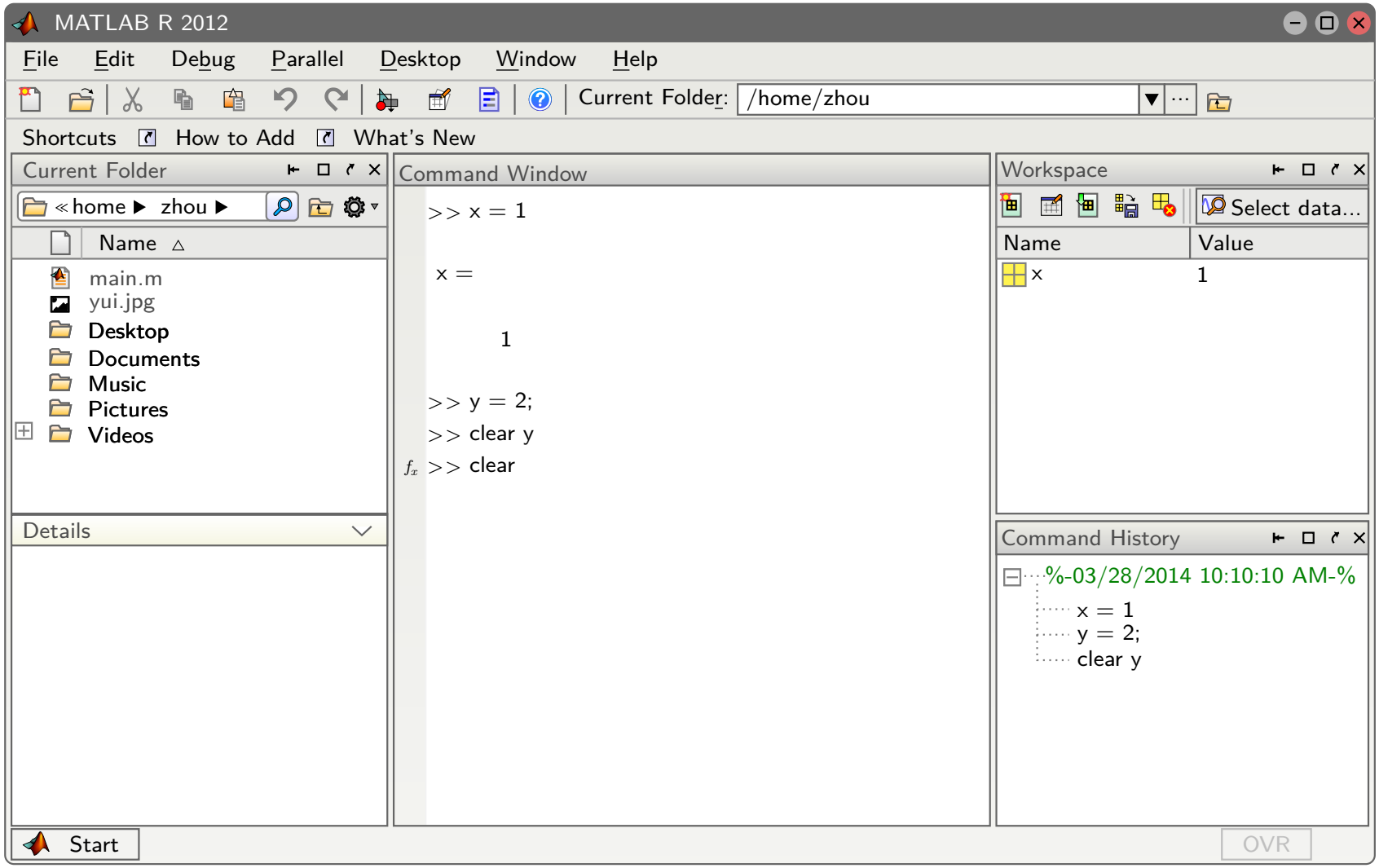
主窗介绍


MATLAB R 2012
File Edit Debug Parallel Desktop Window Help
Current Folder: /home/zhou
Shortcuts How to Add What's New
Current Folder
« home ▶ zhou ▶
Name
main.m
yui.jpg
Desktop
Documents
Music
Pictures
Videos
Details
Command Window
>> x = 1
x =
1
>> y = 2;
>> clear y
Workspace
Select data...
Name
Value
x 1
y 2
Command History
%-03/28/2014 10:10:10 AM-%
x = 1
y = 2;
Start
OVR

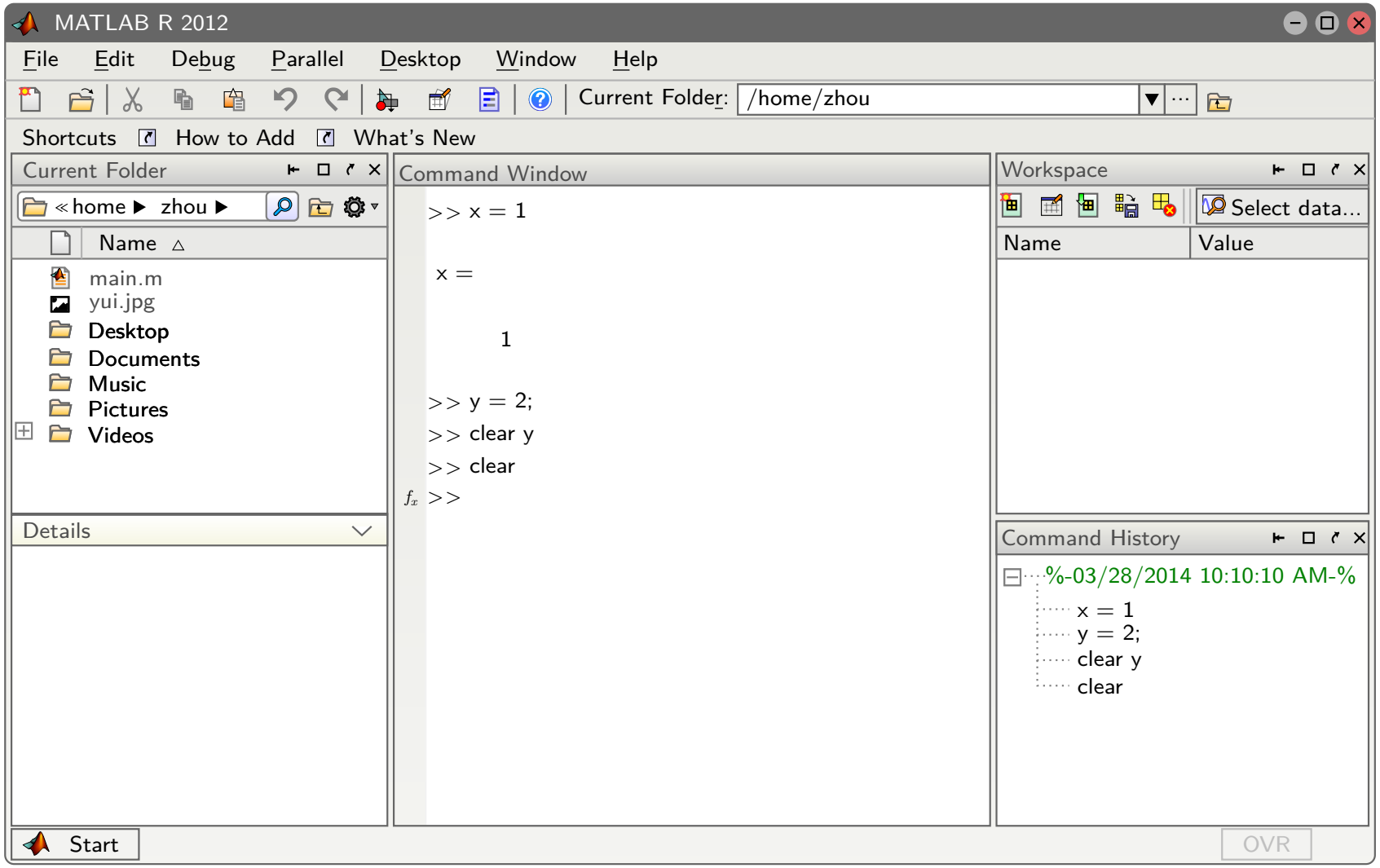
主窗介绍


MATLAB R 2012
File Edit Debug Parallel Desktop Window Help
Current Folder: /home/zhou
Shortcuts How to Add What's New
Current Folder
« home ▶ zhou ▶
Name
main.m
yui.jpg
Desktop
Documents
Music
Pictures
Videos
Details
Command Window
>> x = 1
x =
1
>> y = 2;
>> clear y
>>
Workspace
Select data...
Name
Value
x
1
Command History
%-03/28/2014 10:10:10 AM-%
x = 1
y = 2;
clear y
Start
OVR

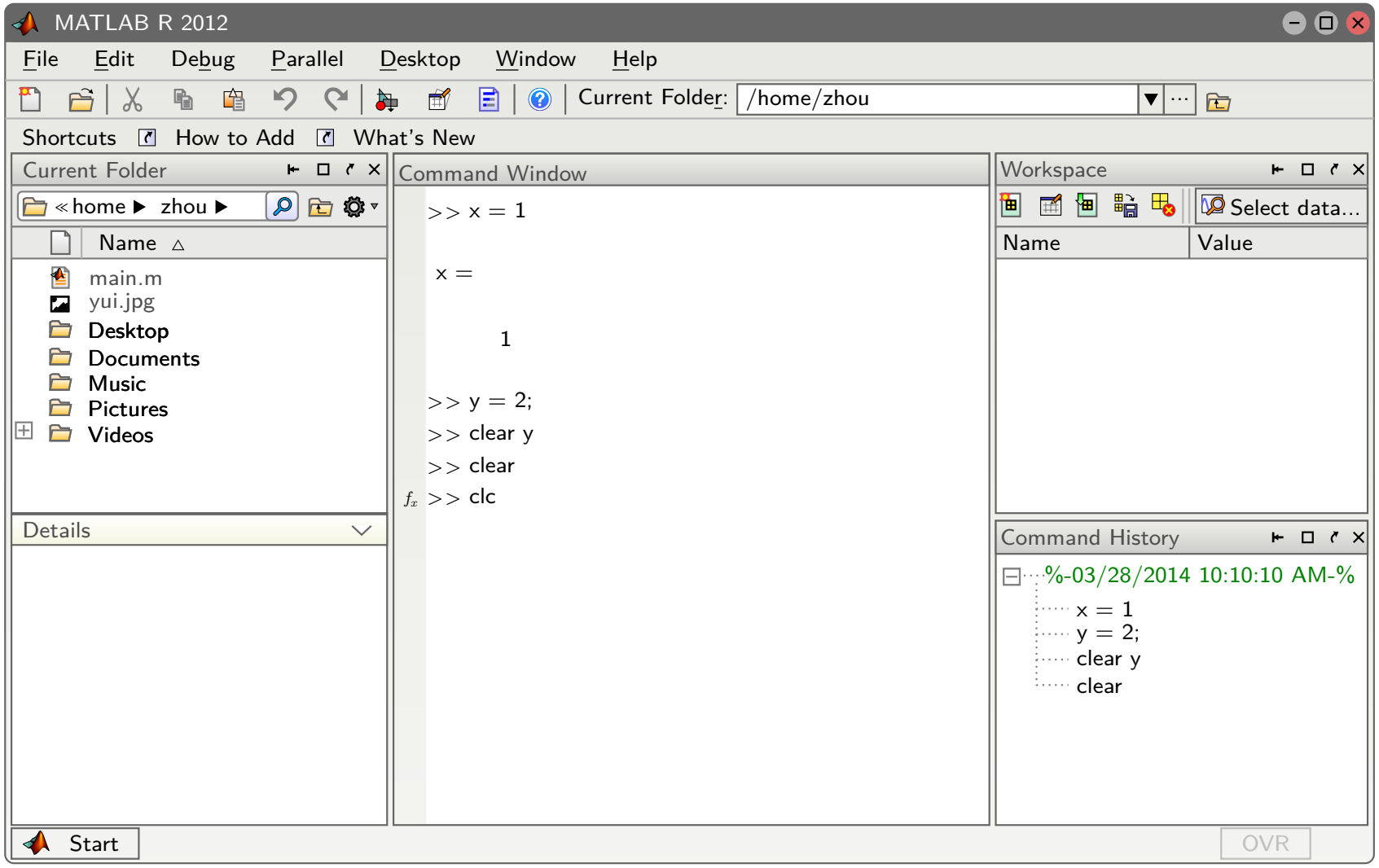
主窗介绍


MATLAB R 2012
File Edit Debug Parallel Desktop Window Help
Current Folder: /home/zhou
Shortcuts How to Add What's New
Current Folder
« home ▶ zhou ▶
Name
main.m
yui.jpg
Desktop
Documents
Music
Pictures
Videos
Details
Command Window
>> x = 1
x =
1
>> y = 2;
>> clear y
>> clear
Workspace
Select data...
Name
Value
x
1
Command History
%-03/28/2014 10:10:10 AM-%
x = 1
y = 2;
clear y
Start
OVR

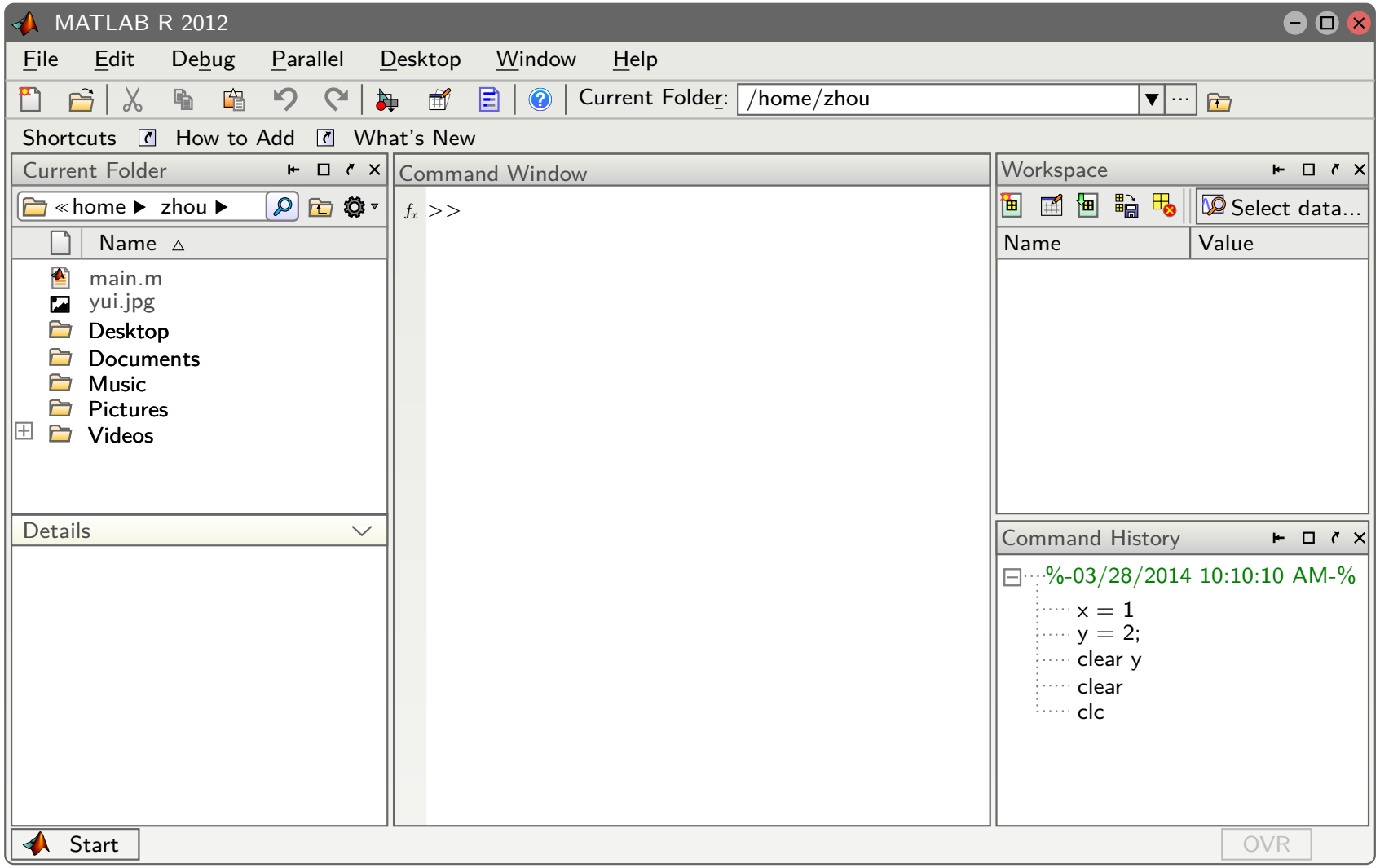
主窗介绍


MATLAB R 2012
File Edit Debug Parallel Desktop Window Help
Current Folder: /home/zhou
Shortcuts How to Add What's New
Current Folder
« home ▶ zhou ▶
Name
main.m
yui.jpg
Desktop
Documents
Music
Pictures
Videos
Details
Command Window
>> x = 1
x =
1
>> y = 2;
>> clear y
>> clear
>>
Workspace
Select data...
Name
Value
Command History
%-03/28/2014 10:10:10 AM-%
x = 1
y = 2;
clear y
clear
Start
OVR

主窗介绍


MATLAB R 2012
File Edit Debug Parallel Desktop Window Help
Current Folder: /home/zhou
Shortcuts How to Add What's New
Current Folder
« home ▶ zhou ▶
Name
main.m
yui.jpg
Desktop
Documents
Music
Pictures
Videos
Details
Command Window
>> x = 1
x =
1
>> y = 2;
>> clear y
>> clear
>> clc
Workspace
Select data...
Name
Value
Command History
%-03/28/2014 10:10:10 AM-%
x = 1
y = 2;
clear y
clear
Start
OVR

主窗介绍


MATLAB R 2012
File Edit Debug Parallel Desktop Window Help
Current Folder: /home/zhou
Shortcuts How to Add What's New
Current Folder
« home ▶ zhou ▶
Name
main.m
yui.jpg
Desktop
Documents
Music
Pictures
Videos
Details
Command Window
>>
Workspace
Select data...
Name
Value
Command History
%-03/28/2014 10:10:10 AM-%
x = 1
y = 2;
clear y
clear
clc
Start
OVR

脚本窗口

Editor-/home/zhou/main.m

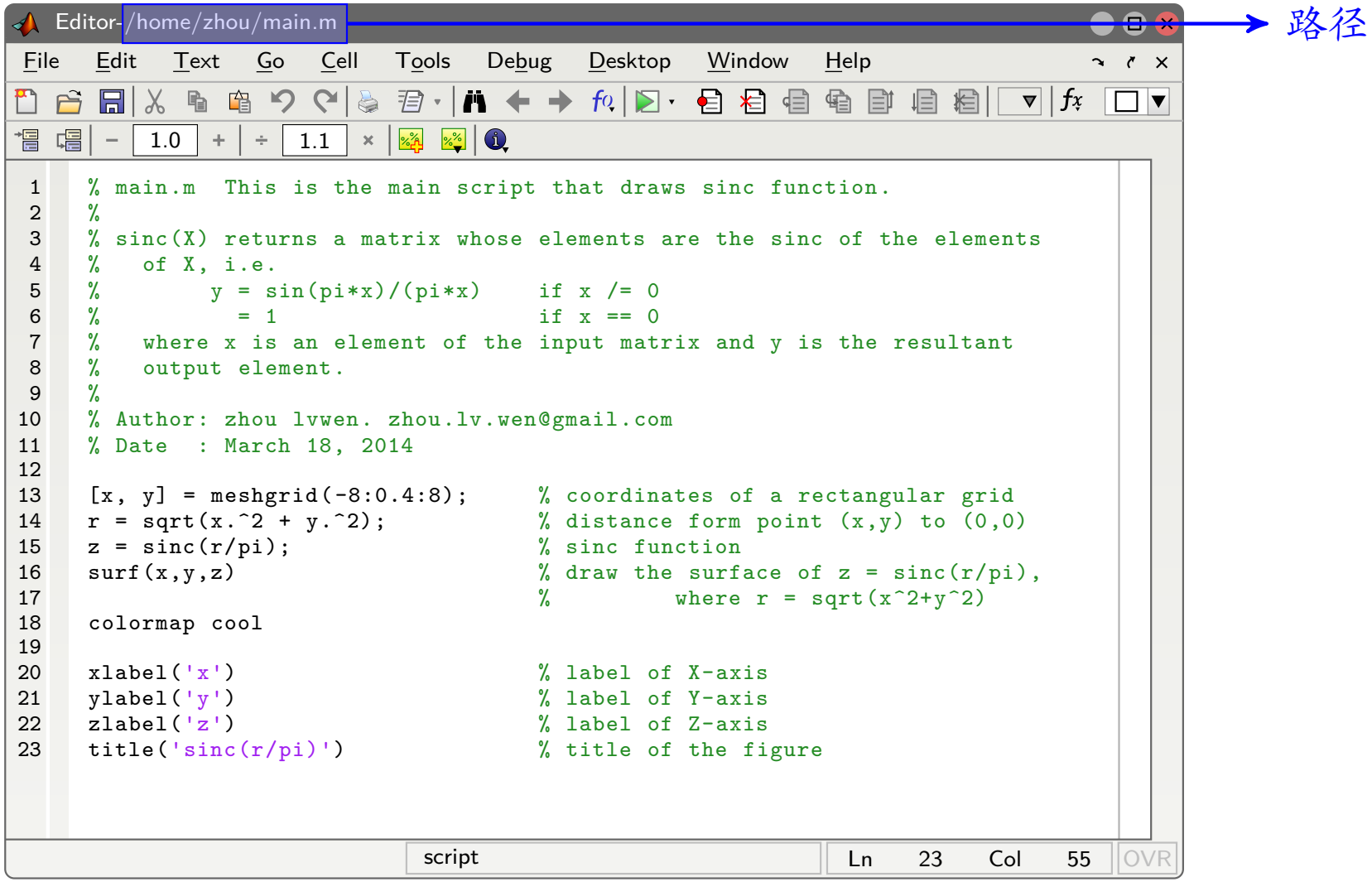
File Edit Text Go Cell Tools Debug Desktop Window Help

1.0 1.1

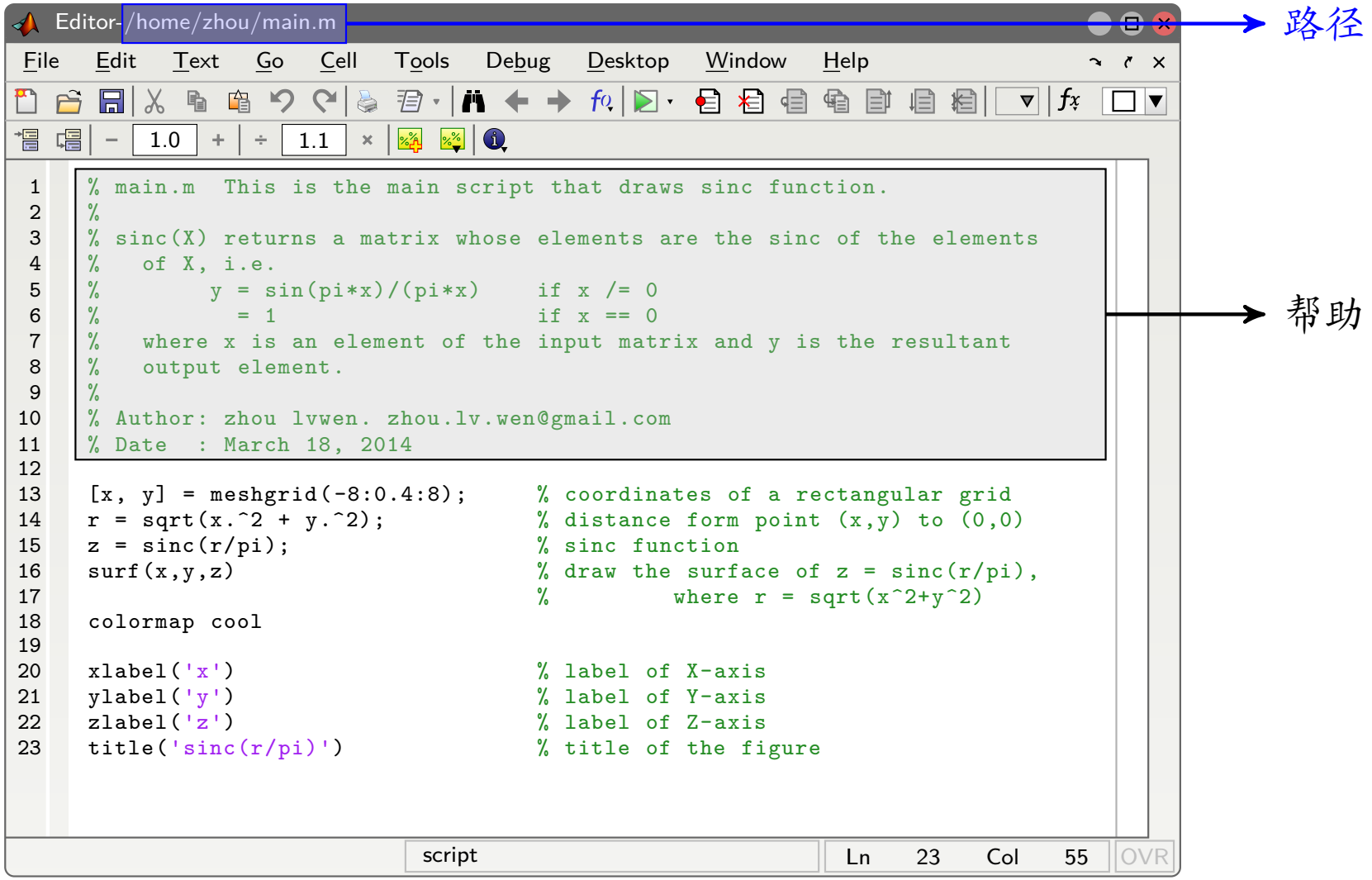
```
% main.m  This is the main script that draws sinc function.
%
% sinc(X) returns a matrix whose elements are the sinc of the elements
%   of X, i.e.
%        y = sin(pi*x)/(pi*x)     if x /= 0
%          = 1                    if x == 0
%   where x is an element of the input matrix and y is the resultant
%   output element.
%
% Author: zhou lvwen. zhou.lv.wen@gmail.com
% Date  : March 18, 2014

[x, y] = meshgrid(-8:0.4:8);      % coordinates of a rectangular grid
r = sqrt(x.^2 + y.^2);            % distance form point (x,y) to (0,0)
z = sinc(r/pi);                   % sinc function
surf(x,y,z)                       % draw the surface of z = sinc(r/pi),
                                  %         where r = sqrt(x^2+y^2)
colormap cool

xlabel('x')                       % label of X-axis
ylabel('y')                       % label of Y-axis
zlabel('z')                       % label of Z-axis
title('sinc(r/pi)')               % title of the figure
```

script Ln 23 Col 55 OVR

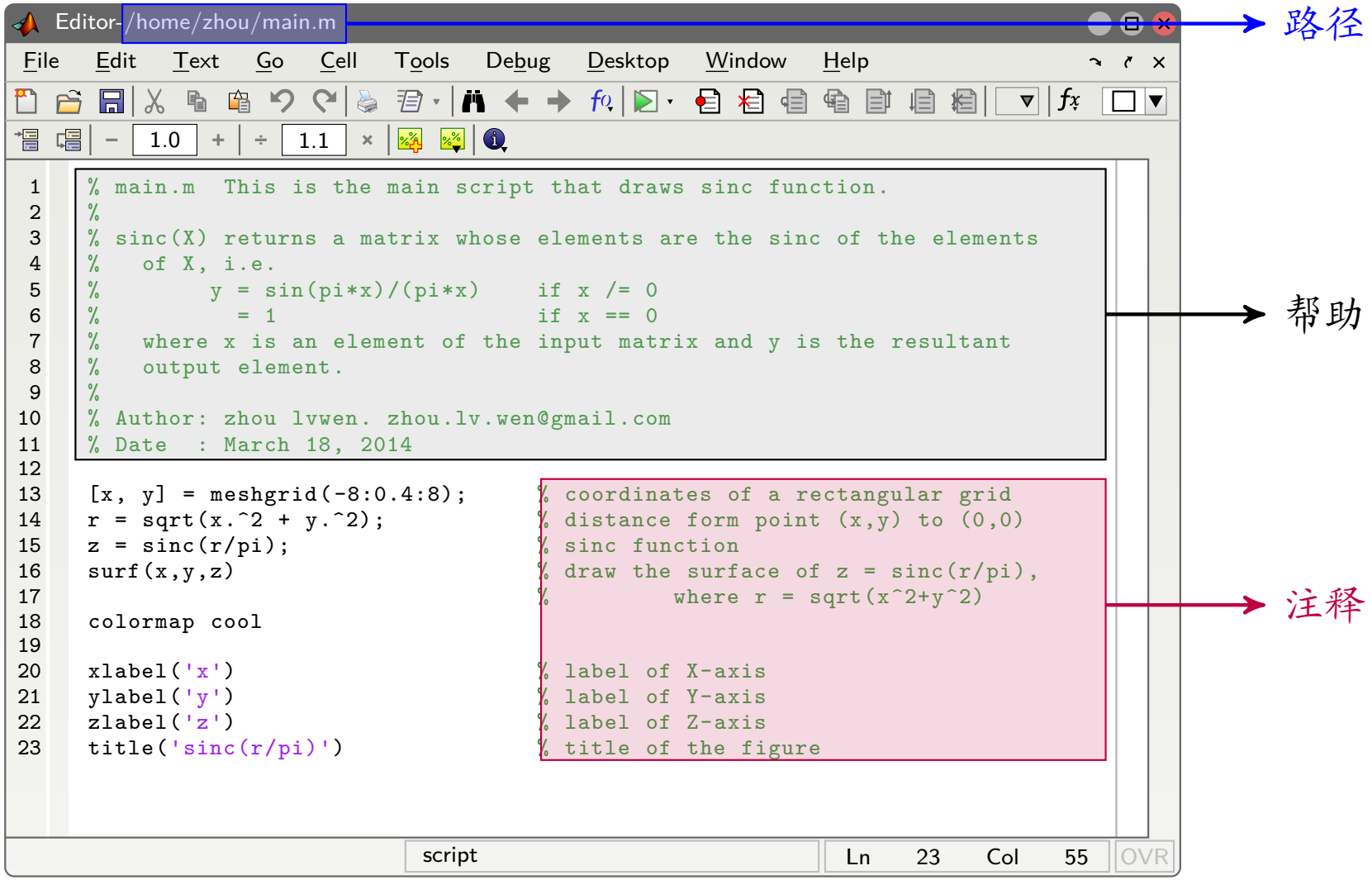
脚本窗口


Editor-/home/zhou/main.m
路径
File Edit Text Go Cell Tools Debug Desktop Window Help
1.0
1.1
% main.m This is the main script that draws sinc function.
%
% sinc(X) returns a matrix whose elements are the sinc of the elements
%   of X, i.e.
%   y = sin(pi*x)/(pi*x)   if x /= 0
%   = 1   if x == 0
%   where x is an element of the input matrix and y is the resultant
%   output element.
%
% Author: zhou lvwen. zhou.lv.wen@gmail.com
% Date : March 18, 2014
[x, y] = meshgrid(-8:0.4:8);   % coordinates of a rectangular grid
r = sqrt(x.^2 + y.^2);   % distance form point (x,y) to (0,0)
z = sinc(r/pi);   % sinc function
surf(x,y,z)   % draw the surface of z = sinc(r/pi),
                                  %   where r = sqrt(x^2+y^2)
colormap cool
xlabel('x')   % label of X-axis
ylabel('y')   % label of Y-axis
zlabel('z')   % label of Z-axis
title('sinc(r/pi)')   % title of the figure
script
Ln 23 Col 55
OVR

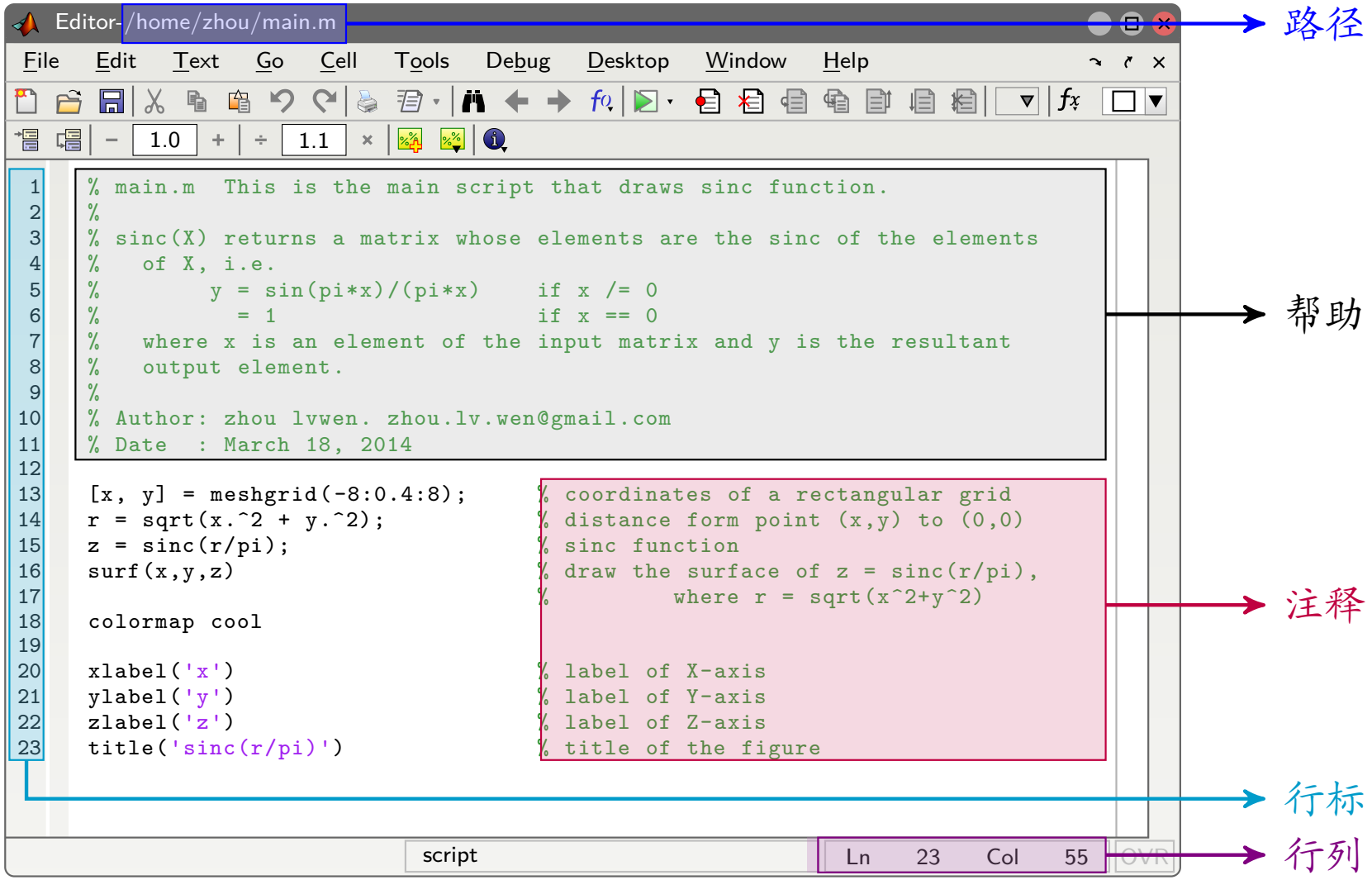
脚本窗口


Editor-/home/zhou/main.m
路径
File Edit Text Go Cell Tools Debug Desktop Window Help
1.0
1.1
帮助
% main.m This is the main script that draws sinc function.
%
% sinc(X) returns a matrix whose elements are the sinc of the elements
%   of X, i.e.
%   y = sin(pi*x)/(pi*x)   if x /= 0
%   = 1   if x == 0
%   where x is an element of the input matrix and y is the resultant
%   output element.
%
% Author: zhou lvwen. zhou.lv.wen@gmail.com
% Date : March 18, 2014
[x, y] = meshgrid(-8:0.4:8);   % coordinates of a rectangular grid
r = sqrt(x.^2 + y.^2);   % distance form point (x,y) to (0,0)
z = sinc(r/pi);   % sinc function
surf(x,y,z)   % draw the surface of z = sinc(r/pi),
                                  %   where r = sqrt(x^2+y^2)
colormap cool
xlabel('x')   % label of X-axis
ylabel('y')   % label of Y-axis
zlabel('z')   % label of Z-axis
title('sinc(r/pi)')   % title of the figure
script
Ln 23 Col 55
OVR

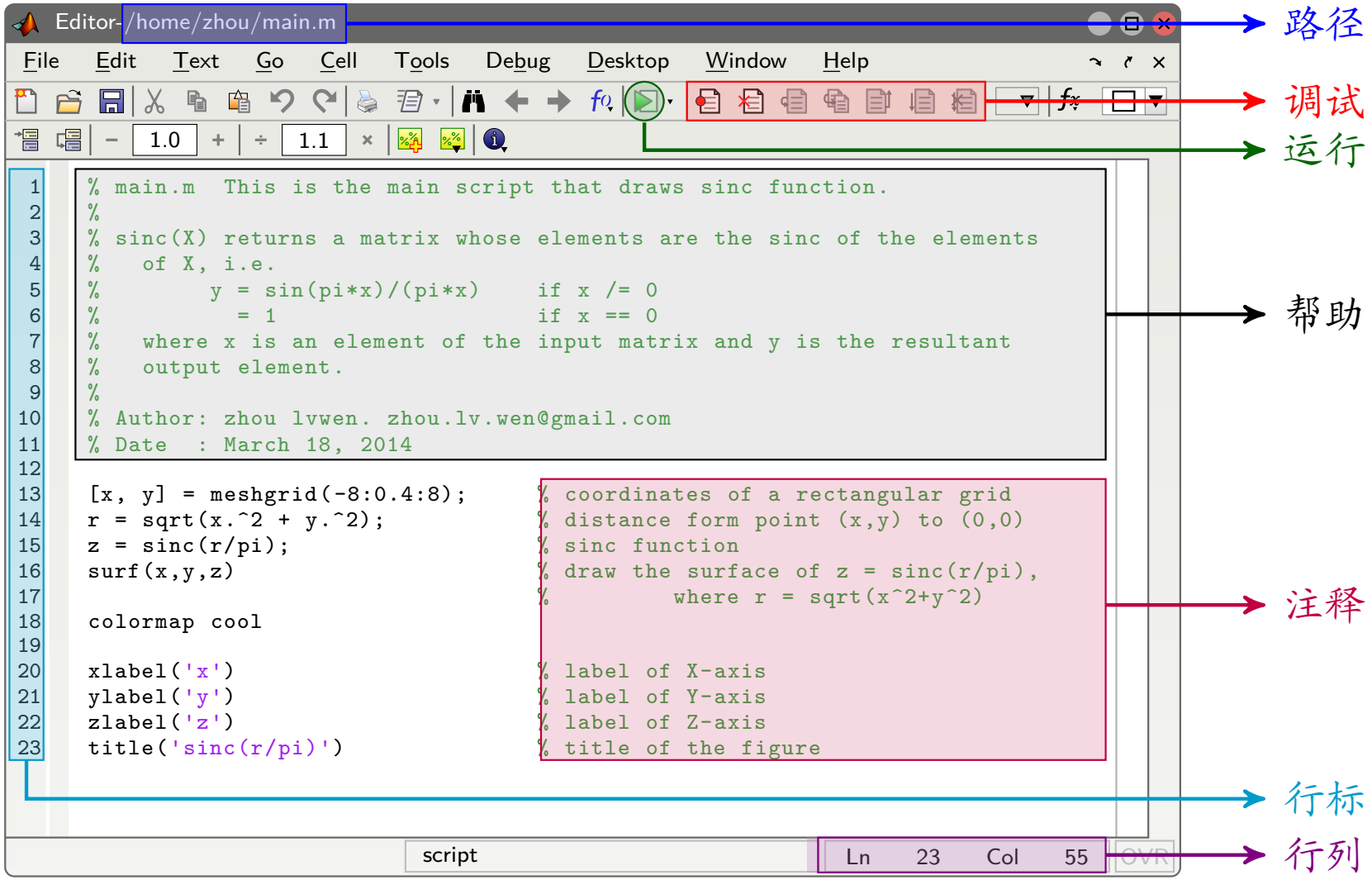
脚本窗口


Editor-/home/zhou/main.m
File Edit Text Go Cell Tools Debug Desktop Window Help
1.0
1.1
% main.m This is the main script that draws sinc function.
%
% sinc(X) returns a matrix whose elements are the sinc of the elements
% of X, i.e.
% y = sin(pi*x)/(pi*x) if x /= 0
% = 1 if x == 0
% where x is an element of the input matrix and y is the resultant
% output element.
%
% Author: zhou lvwen. zhou.lv.wen@gmail.com
% Date : March 18, 2014
[x, y] = meshgrid(-8:0.4:8); % coordinates of a rectangular grid
r = sqrt(x.^2 + y.^2); % distance form point (x,y) to (0,0)
z = sinc(r/pi); % sinc function
surf(x,y,z) % draw the surface of z = sinc(r/pi),
% where r = sqrt(x^2+y^2)
colormap cool
xlabel('x') % label of X-axis
ylabel('y') % label of Y-axis
zlabel('z') % label of Z-axis
title('sinc(r/pi)') % title of the figure
script
Ln 23 Col 55
OVR
路径
帮助
注释

脚本窗口


Editor-/home/zhou/main.m
File Edit Text Go Cell Tools Debug Desktop Window Help
1.0
1.1
% main.m This is the main script that draws sinc function.
%
% sinc(X) returns a matrix whose elements are the sinc of the elements
% of X, i.e.
% y = sin(pi*x)/(pi*x) if x /= 0
% = 1 if x == 0
% where x is an element of the input matrix and y is the resultant
% output element.
%
% Author: zhou lvwen. zhou.lv.wen@gmail.com
% Date : March 18, 2014
[x, y] = meshgrid(-8:0.4:8); % coordinates of a rectangular grid
r = sqrt(x.^2 + y.^2); % distance form point (x,y) to (0,0)
z = sinc(r/pi); % sinc function
surf(x,y,z) % draw the surface of z = sinc(r/pi),
% where r = sqrt(x^2+y^2)
colormap cool
xlabel('x') % label of X-axis
ylabel('y') % label of Y-axis
zlabel('z') % label of Z-axis
title('sinc(r/pi)') % title of the figure
script
Ln 23 Col 55
OVR
路径
帮助
注释
行标
行列

脚本窗口


Editor-/home/zhou/main.m
File Edit Text Go Cell Tools Debug Desktop Window Help
1.0
1.1
% main.m This is the main script that draws sinc function.
%
% sinc(X) returns a matrix whose elements are the sinc of the elements
% of X, i.e.
% y = sin(pi*x)/(pi*x) if x /= 0
% = 1 if x == 0
% where x is an element of the input matrix and y is the resultant
% output element.
%
% Author: zhou lvwen. zhou.lv.wen@gmail.com
% Date : March 18, 2014
[x, y] = meshgrid(-8:0.4:8); % coordinates of a rectangular grid
r = sqrt(x.^2 + y.^2); % distance form point (x,y) to (0,0)
z = sinc(r/pi); % sinc function
surf(x,y,z) % draw the surface of z = sinc(r/pi),
% where r = sqrt(x^2+y^2)
colormap cool
xlabel('x') % label of X-axis
ylabel('y') % label of Y-axis
zlabel('z') % label of Z-axis
title('sinc(r/pi)') % title of the figure
script
Ln 23 Col 55
OVR
路径
调试
运行
帮助
注释
行标
行列

图形窗口

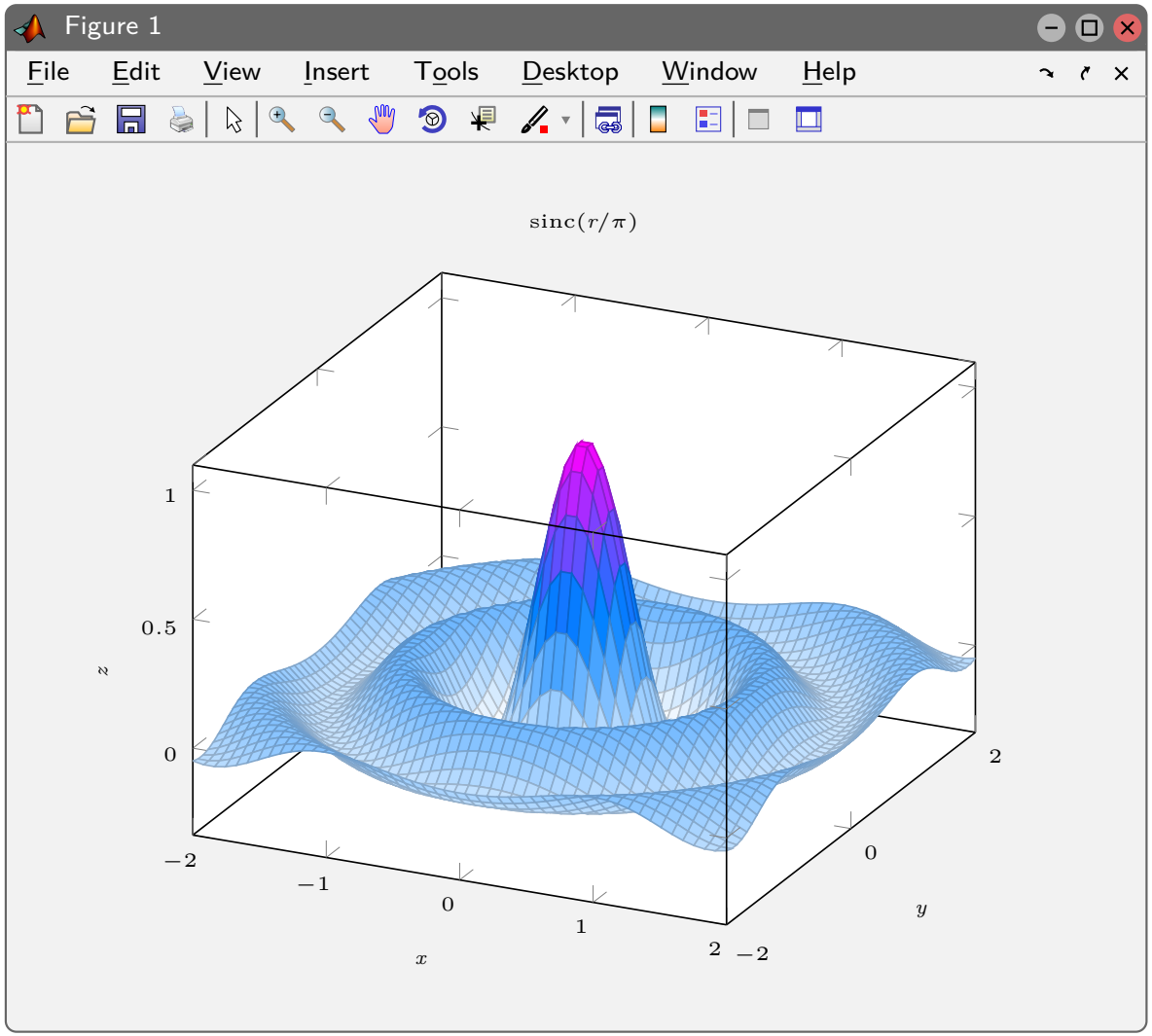


Figure 1
File Edit View Insert Tools Desktop Window Help
sinc(r/π)
1
0.5
z
0
−2
−1
0
1
2
x
2
0
−2
y

获得帮助

帮助文档

- 如果你知道一个函数名，想了解它的用法，你可以用 'help' 命令得到它的帮助文档：

  ```
  >> help functionname
  ```

- 如果你了解含某个关键词的函数，你可以用 'lookfor' 命令得到相关的函数：

  ```
  >> lookfor keyword
  ```

网络资源

- Mathworks 文件交流中心：▸ Mathworks
- Github 代码托管网站：▸ Github

实数，复数，行向量，列向量，矩阵的赋值

Command Window

f_x >>

实数, 复数, 行向量, 列向量, 矩阵的赋值

Command Window

```
>> x = 5
```

实数, 复数, 行向量, 列向量, 矩阵的赋值

Command Window

```
>> x = 5

x =

     5

fx >>
```

实数, 复数, 行向量, 列向量, 矩阵的赋值

Command Window

```
>> x = 5

x =

     5

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

实数，复数，行向量，列向量，矩阵的赋值

Command Window

```
>> x = 5

x =

     5

>> x = [1 2 3]

x =

     1     2     3

fx >>
```

实数，复数，行向量，列向量，矩阵的赋值

Command Window

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

实数，复数，行向量，列向量，矩阵的赋值

Command Window

```
>> x = 5

x =

     5

>> x = [1 2 3]

x =

     1     2     3

>> x = [1;2;3]

x =

     1
     2
     3

fx >>
```

实数，复数，行向量，列向量，矩阵的赋值

Command Window

```
>> x = 5

x =

     5

>> x = [1 2 3]

x =

     1     2     3

>> x = [1;2;3]

x =

     1
     2
     3

>> clc
```

实数，复数，行向量，列向量，矩阵的赋值

Command Window

f_x >>

实数, 复数, 行向量, 列向量, 矩阵的赋值

Command Window

```
>> x = [1 2 3; 4 5 6; 7 8 9]
```

实数, 复数, 行向量, 列向量, 矩阵的赋值

Command Window

```
>> x = [1 2 3; 4 5 6; 7 8 9]

x =

     1     2     3
     4     5     6
     7     8     9

fx >>
```

实数，复数，行向量，列向量，矩阵的赋值

Command Window

```
>> x = [1 2 3; 4 5 6; 7 8 9]

x =

     1     2     3
     4     5     6
     7     8     9

>> y = [1 2 3
        4 5 6]
```

实数，复数，行向量，列向量，矩阵的赋值

Command Window

```
>> x = [1 2 3; 4 5 6; 7 8 9]

x =

     1     2     3
     4     5     6
     7     8     9

>> y = [1 2 3
        4 5 6]

y =

     1     2     3
     4     5     6

fx >>
```

向量的一般赋值方法

Command Window

f_x >>

向量的一般赋值方法

Command Window

```
>> x = [0:2]
```

向量的一般赋值方法

Command Window

```
>> x = [0:2]

x =

    0.00    1.00    2.00

fx >>
```

向量的一般赋值方法

Command Window

```
>> x = [0:2]

x =

   0.00    1.00    2.00

>> x = [0:2]'
```

向量的一般赋值方法

Command Window

```
>> x = [0:2]

x =

    0.00    1.00    2.00

>> x = [0:2]'

x =

    0.00
    1.00
    2.00

fx >>
```

向量的一般赋值方法

Command Window

```
>> x = [0:2]

x =

   0.00    1.00    2.00

>> x = [0:2]'

x =

   0.00
   1.00
   2.00

>> x = [0:0.5:2]
```

向量的一般赋值方法

Command Window

```
>> x = [0:2]

x =

   0.00    1.00    2.00

>> x = [0:2]'

x =

   0.00
   1.00
   2.00

>> x = [0:0.5:2]

x =

   0.00    0.50    1.00    1.50    2.00

fx >>
```

向量的一般赋值方法

Command Window

```
>> x = [0:2]

x =

   0.00    1.00    2.00

>> x = [0:2]'

x =

   0.00
   1.00
   2.00

>> x = [0:0.5:2]

x =

   0.00    0.50    1.00    1.50    2.00

>> x = linspace(0, 2, 5)
```

向量的一般赋值方法

Command Window

```
>> x = [0:2]

x =

   0.00    1.00    2.00

>> x = [0:2]'

x =

   0.00
   1.00
   2.00

>> x = [0:0.5:2]

x =

   0.00    0.50    1.00    1.50    2.00

>> x = linspace(0, 2, 5)

x =

   0.00    0.50    1.00    1.50    2.00

fx >>
```

常用矩阵

Command Window

f_x >>

常用矩阵

Command Window

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

常用矩阵

Command Window

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

x =

   0.00    0.00    0.00
   0.00    0.00    0.00

fx >>
```

常用矩阵

Command Window

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

x =

   0.00    0.00    0.00
   0.00    0.00    0.00

>> y = ones(2)
```

常用矩阵

Command Window

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

x =

   0.00    0.00    0.00
   0.00    0.00    0.00

>> y = ones(2)

x =

   1.00    1.00
   1.00    1.00

fx >>
```

常用矩阵

Command Window

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

x =

   0.00    0.00    0.00
   0.00    0.00    0.00

>> y = ones(2)

x =

   1.00    1.00
   1.00    1.00

>> x = eye(2)
```

常用矩阵

Command Window

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

x =

   0.00    0.00    0.00
   0.00    0.00    0.00

>> y = ones(2)

x =

   1.00    1.00
   1.00    1.00

>> x = eye(2)

x =

   1.00    0.00
   0.00    1.00

fx >>
```

固定变量

Command Window

f_x >>

固定变量

Command Window

```
>> pi
```

固定变量

Command Window

```
>> pi
ans =
   3.1416
fx >>
```

固定变量

Command Window

```
>> pi
ans =
   3.1416
>> z = i
```

固定变量

Command Window

```
>> pi
ans =
   3.1416
>> z = i
z =
   0.00 + 1.00i
fx >>
```

固定变量

Command Window

```
>> pi
ans =
   3.1416
>> z = i
z =
   0.00 + 1.00i
>> x = 1/0
```

固定变量

Command Window

```
>> pi
ans =
   3.1416
>> z = i
z =
   0.00 + 1.00i
>> x = 1/0
x =
    Inf
>>
```

固定变量

Command Window

```
>> pi
ans =
   3.1416
>> z = i
z =
   0.00 + 1.00i
>> x = 1/0
x =
    Inf
>> 0/0
```

固定变量

Command Window

```
>> pi
ans =
   3.1416
>> z = i
z =
   0.00 + 1.00i
>> x = 1/0
x =
    Inf
>> 0/0
ans =
    NaN
fx >>
```

矩阵运算和数组运算

Command Window

f_x >>

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
fx >>
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>>
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>> C = A + B
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>> C = A + B

C =

     2     5     8
    10    14     6
     9    12    15

fx >>
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>> C = A + B

C =

     2     5     8
    10    14     6
     9    12    15

>> D = A - B
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>> C = A + B

C =

     2     5     8
    10    14     6
     9    12    15

>> D = A - B

D =

     0    -1    -2
    -2    -4     6
     5     4    03

fx >>
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>> C = A + B

C =

     2     5     8
    10    14     6
     9    12    15

>> D = A - B

D =

     0    -1    -2
    -2    -4     6
     5     4    03

>> clc
```

矩阵运算和数组运算

Command Window

f_x >>

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
fx >>
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>>
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>> E = A * B
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>> E = A * B

E =

     19    33    23
     46    81    56
     73   129    89

fx >>
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>> E = A * B

E =

     19    33    23
     46    81    56
     73   129    89

>> F = A.* B
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>> E = A * B

E =

    19    33    23
    46    81    56
    73   129    89

>> F = A.* B

F =

     1     6    15
    24    45     0
    14    32    54

fx >>
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>> E = A * B

E =

    19    33    23
    46    81    56
    73   129    89

>> F = A.* B

F =

     1     6    15
    24    45     0
    14    32    54

>> clc
```

矩阵运算和数组运算

Command Window

f_x >>

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
fx >>
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>>
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>> G = A / B
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>> G = A / B

G =

         0         0    0.50
   -3.00    0.00    3.50
   -6.00    0.00    6.50

fx >>
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>> G = A / B

G =

         0         0    0.50
   -3.00    0.00    3.50
   -6.00    0.00    6.50

>> H = A./ B
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>> G = A / B

G =

         0         0    0.50
   -3.00    0.00    3.50
   -6.00    0.00    6.50

>> H = A./ B

H =

    1.00    0.67    0.60
    0.67    0.56     inf
    3.50    2.00    1.50

fx >>
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>> G = A / B

G =

         0         0    0.50
   -3.00    0.00    3.50
   -6.00    0.00    6.50

>> H = A./ B

H =

    1.00    0.67    0.60
    0.67    0.56     inf
    3.50    2.00    1.50

>> clc
```

矩阵运算和数组运算

Command Window

f_x >>

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
fx >>
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>>
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>> I = A ^ 2
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>> I = A ^ 2

I =

    30    36    42
    66    81    96
   102   126   150

fx >>
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>> I = A ^ 2

I =

     30    36    42
     66    81    96
    102   126   150

>> J = A.^ 2
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>> I = A ^ 2

I =

    30    36    42
    66    81    96
   102   126   150

>> J = A.^ 2

J =

     1     4     9
    16    25    36
    49    64    81

fx >>
```

矩阵运算和数组运算

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = [1 3 5; 6 9 0; 2 4 6];
>> I = A ^ 2

I =

     30    36    42
     66    81    96
    102   126   150

>> J = A.^ 2

J =

      1     4     9
     16    25    36
     49    64    81

>> clc
```

数组和数组行列块操作：取值

Command Window

f_x >>

数组和数组行列块操作：取值

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>>
```

数组和数组行列块操作：取值

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> x = A(1, 3)
```

数组和数组行列块操作：取值

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> x = A(1, 3)

x =

     3

fx >>
```

数组和数组行列块操作：取值

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> x = A(1, 3)

x =

     3

>> y = A(2, :)
```

数组和数组行列块操作：取值

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> x = A(1, 3)

x =

     3

>> y = A(2, :)

y =

     4     5     6

fx >>
```

数组和数组行列块操作：取值

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> x = A(1, 3)

x =

     3

>> y = A(2, :)

y =

     4     5     6

>> z = A(1:2, 1:3)
```

数组和数组行列块操作：取值

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> x = A(1, 3)

x =

     3

>> y = A(2, :)

y =

     4     5     6

>> z = A(1:2, 1:3)

z =

     1     2     3
     4     5     6

fx >>
```

数组和数组行列块操作: 赋值

Command Window

f_x >>

数组和数组行列块操作：赋值

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
fx >>
```

数组和数组行列块操作：赋值

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> A(1, 3) = 0
```

数组和数组行列块操作：赋值

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> A(1, 3) = 0

A =

     1     2     0
     4     5     6
     7     8     9

fx >>
```

数组和数组行列块操作：赋值

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> A(1, 3) = 0

A =

     1     2     0
     4     5     6
     7     8     9

>> A(2, :) = [6 5 4]
```

数组和数组行列块操作：赋值

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> A(1, 3) = 0

A =

     1     2     0
     4     5     6
     7     8     9

>> A(2, :) = [6 5 4]

A =

     1     2     0
     6     5     4
     7     8     9

fx >>
```

数组和数组行列块操作：赋值

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> A(1, 3) = 0

A =

     1     2     0
     4     5     6
     7     8     9

>> A(2, :) = [6 5 4]

A =

     1     2     0
     6     5     4
     7     8     9

>> A(1:2, 1:2) = [-1 -2; -3 -4]
```

数组和数组行列块操作：赋值

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> A(1, 3) = 0

A =

     1     2     0
     4     5     6
     7     8     9

>> A(2, :) = [6 5 4]

A =

     1     2     0
     6     5     4
     7     8     9

>> A(1:2, 1:2) = [-1 -2; -3 -4]

A =

    -1    -2     0
    -3    -4     4
     7     8     9
```

比较和逻辑运算

Command Window

f_x >>

比较和逻辑运算

Command Window

```
>> x = [1  2  3  4  5  6  7  8  9];
>>
```

比较和逻辑运算

Command Window

```
>> x = [1  2  3  4  5  6  7  8  9];
>> y = [1  4  3  8  6  5  7  2  9];
>>
```

比较和逻辑运算

Command Window

```
>> x = [1  2  3  4  5  6  7  8  9];
>> y = [1  4  3  8  6  5  7  2  9];
>> eq = (x==y)
```

比较和逻辑运算

Command Window

```
>> x = [1  2  3  4  5  6  7  8  9];
>> y = [1  4  3  8  6  5  7  2  9];
>> eq = (x==y)

eq =

     1     0     1     0     0     0     1     0     1

fx >>
```

比较和逻辑运算

Command Window

```
>> x = [1  2  3  4  5  6  7  8  9];
>> y = [1  4  3  8  6  5  7  2  9];
>> eq = (x==y)

eq =

     1     0     1     0     0     0     1     0     1

>> xy = (x>5)&(y<7)
```

比较和逻辑运算

Command Window

```
>> x = [1  2  3  4  5  6  7  8  9];
>> y = [1  4  3  8  6  5  7  2  9];
>> eq = (x==y)
eq =
     1     0     1     0     0     0     1     0     1
>> xy = (x>5)&(y<7)
xy =
     0     0     0     0     0     1     0     1     0
fx >>
```

比较和逻辑运算

Command Window

```
>> x = [1  2  3  4  5  6  7  8  9];
>> y = [1  4  3  8  6  5  7  2  9];
>> eq = (x==y)

eq =

     1     0     1     0     0     0     1     0     1

>> xy = (x>5)&(y<7)

xy =

     0     0     0     0     0     1     0     1     0

>> xoy = (x>5)|(y<7)
```

比较和逻辑运算

Command Window

```
>> x = [1  2  3  4  5  6  7  8  9];
>> y = [1  4  3  8  6  5  7  2  9];
>> eq = (x==y)
eq =
     1     0     1     0     0     0     1     0     1
>> xy = (x>5)&(y<7)
xy =
     0     0     0     0     0     1     0     1     0
>> xoy = (x>5)|(y<7)
xoy =
     1     1     1     0     1     1     1     1     1
fx >>
```

比较和逻辑运算

Command Window

```
>> x = [1  2  3  4  5  6  7  8  9];
>> y = [1  4  3  8  6  5  7  2  9];
>> eq = (x==y)
eq =
     1     0     1     0     0     0     1     0     1
>> xy = (x>5)&(y<7)
xy =
     0     0     0     0     0     1     0     1     0
>> xoy = (x>5)|(y<7)
xoy =
     1     1     1     0     1     1     1     1     1
>> xory = xor(x>5,y<7)
```

比较和逻辑运算

Command Window

```
>> x = [1  2  3  4  5  6  7  8  9];
>> y = [1  4  3  8  6  5  7  2  9];
>> eq = (x==y)
eq =
     1     0     1     0     0     0     1     0     1
>> xy = (x>5)&(y<7)
xy =
     0     0     0     0     0     1     0     1     0
>> xoy = (x>5)|(y<7)
xoy =
     1     1     1     0     1     1     1     1     1
>> xory = xor(x>5,y<7)
xory =
     1     1     1     0     1     0     1     0     1
fx >>
```

比较和逻辑运算

Command Window

f_x >>

比较和逻辑运算

Command Window

```
>> x = [1 -2  3 -4  5 -6  7 -8  9];
>>
```

比较和逻辑运算

Command Window

```
>> x = [1 -2  3 -4  5 -6  7 -8  9];
>> x(x<0) = 0
```

比较和逻辑运算

Command Window

```
>> x = [1 -2  3 -4  5 -6  7 -8  9];
>> x(x<0) = 0

x =

     1     0     3     0     5     0     7     0     9

fx >>
```

比较和逻辑运算

Command Window

```
>> x = [1 -2  3 -4  5 -6  7 -8  9];
>> x(x<0) = 0

x =

     1     0     3     0     5     0     7     0     9

>> y = [1  2  3;-4  5  6;  7  8  9];
>>
```

比较和逻辑运算

Command Window

```
>> x = [1 -2  3 -4  5 -6  7 -8  9];
>> x(x<0) = 0

x =

     1     0     3     0     5     0     7     0     9

>> y = [1  2  3;-4  5  6;  7  8  9];
>> y(y(:,1)<0,:) = 0
```

比较和逻辑运算

Command Window

```
>> x = [1 -2  3 -4  5 -6  7 -8  9];
>> x(x<0) = 0

x =

     1     0     3     0     5     0     7     0     9

>> y = [1  2  3;-4  5  6;  7  8  9];
>> y(y(:,1)<0,:) = 0

y =

     1     2     3

     0     0     0

     7     8     9

fx >>
```

数组操作函数: flipud, fliplr, rot90

Command Window

f_x >>

数组操作函数: flipud, fliplr, rot90

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
fx >>
```

数组操作函数: flipud, fliplr, rot90

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = flipud(A)
```

数组操作函数: flipud, fliplr, rot90

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = flipud(A)

A =

     7     8     9
     4     5     6
     1     2     3

fx >>
```

数组操作函数: flipud, fliplr, rot90

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = flipud(A)

A =

     7     8     9
     4     5     6
     1     2     3

>> C = rot90(A)
```

数组操作函数: flipud, fliplr, rot90

Command Window

```
>> A = [1 2 3; 4 5 6; 7 8 9];
>> B = flipud(A)

A =

     7     8     9
     4     5     6
     1     2     3

>> C = rot90(A)

C =

     3     6     9
     2     5     8
     1     4     7

fx >>
```

数组操作函数：sum

Command Window

f_x >>

数组操作函数：sum

Command Window

```
>> A = [1 2 3];
fx >>
```

数组操作函数：sum

Command Window

```
>> A = [1 2 3];
>> sum(A)
```

数组操作函数：sum

Command Window

```
>> A = [1 2 3];
>> sum(A)

ans =

     6

fx >>
```

数组操作函数：sum

Command Window

```
>> A = [1 2 3];
>> sum(A)

ans =

      6

>> B = [1 2 3; 4 5 6; 7 8 9];
>>
```

数组操作函数：sum

Command Window

```
>> A = [1 2 3];
>> sum(A)

ans =

     6

>> B = [1 2 3; 4 5 6; 7 8 9];
>> sum(B)
```

数组操作函数：sum

Command Window

```
>> A = [1 2 3];
>> sum(A)

ans =

     6

>> B = [1 2 3; 4 5 6; 7 8 9];
>> sum(B)

ans =

    12    15    18

fx >>
```

数组操作函数：sum

Command Window

```
>> A = [1 2 3];
>> sum(A)

ans =

      6

>> B = [1 2 3; 4 5 6; 7 8 9];
>> sum(B)

ans =

     12    15    18

>> sum(B,2)
```

数组操作函数：sum

Command Window

```
>> A = [1 2 3];
>> sum(A)

ans =

     6

>> B = [1 2 3; 4 5 6; 7 8 9];
>> sum(B)

ans =

    12    15    18

>> sum(B,2)

ans =

     6
    15
    25

fx >>
```

数组操作函数：max, min

Command Window

f_x >>

数组操作函数：max, min

Command Window

```
>> A = [1 2 3];
fx >>
```

数组操作函数：max, min

Command Window

```
>> A = [1 2 3];
>> max(A)
```

数组操作函数：max, min

Command Window

```
>> A = [1 2 3];
>> max(A)

ans =

     3

fx >>
```

数组操作函数：max, min

Command Window

```
>> A = [1 2 3];
>> max(A)

ans =

     3

>> max(A,2)
```

数组操作函数: max, min

Command Window

```
>> A = [1 2 3];
>> max(A)

ans =

     3

>> max(A,2)

ans =

     2     2     3

fx >>
```

数组操作函数: max, min

Command Window

```
>> A = [1 2 3];
>> max(A)

ans =

     3

>> max(A,2)

ans =

     2     2     3

>> B = [1 3 9; 4 8 6];
>>
```

数组操作函数: max, min

Command Window

```
>> A = [1 2 3];
>> max(A)

ans =

     3

>> max(A,2)

ans =

     2     2     3

>> B = [1 3 9; 4 8 6];
>> max(B)
```

数组操作函数: max, min

Command Window

```
>> A = [1 2 3];
>> max(A)

ans =

     3

>> max(A,2)

ans =

     2     2     3

>> B = [1 3 9; 4 8 6];
>> max(B)

ans =

     4     8     9

fx >>
```

数组操作函数: max, min

Command Window

```
>> A = [1 2 3];
>> max(A)

ans =

     3

>> max(A,2)

ans =

     2     2     3

>> B = [1 3 9; 4 8 6];
>> max(B)

ans =

     4     8     9

>> max(B, [], 2)
```

数组操作函数: max, min

Command Window

```
>> A = [1 2 3];
>> max(A)

ans =

     3

>> max(A,2)

ans =

     2     2     3

>> B = [1 3 9; 4 8 6];
>> max(B)

ans =

     4     8     9

>> max(B, [], 2)

ans =

     9
     8
```

常用数学函数: sin, cos, tan, cot, asin, acos, atan, acot

Command Window

f_x >>

常用数学函数: sin, cos, tan, cot, asin, acos, atan, acot

Command Window

```
>> x = 0:pi/6:pi;
```

常用数学函数: sin, cos, tan, cot, asin, acos, atan, acot

Command Window

```
>> x = 0:pi/6:pi;

x =

    0.00   0.52   1.05   1.57   2.09   2.62   3.14

fx >>
```

常用数学函数: sin, cos, tan, cot, asin, acos, atan, acot

Command Window

```
>> x = 0:pi/6:pi;

x =

    0.00   0.52   1.05   1.57   2.09   2.62   3.14

>> y = sin(x)
```

常用数学函数: sin, cos, tan, cot, asin, acos, atan, acot

Command Window

```
>> x = 0:pi/6:pi;
x =
    0.00   0.52   1.05   1.57   2.09   2.62   3.14
>> y = sin(x)
y =
    0.00   0.50   0.87   1.00   0.87   0.50   0.00
fx >>
```

常用数学函数: sin, cos, tan, cot, asin, acos, atan, acot

Command Window

```
>> x = 0:pi/6:pi;
x =
    0.00   0.52   1.05   1.57   2.09   2.62   3.14
>> y = sin(x)
y =
    0.00   0.50   0.87   1.00   0.87   0.50   0.00
>> z = asin(y)
```

常用数学函数: sin, cos, tan, cot, asin, acos, atan, acot

Command Window

```
>> x = 0:pi/6:pi;
x =
    0.00   0.52   1.05   1.57   2.09   2.62   3.14
>> y = sin(x)
y =
    0.00   0.50   0.87   1.00   0.87   0.50   0.00
>> z = asin(y)
z =
    0.00   0.52   1.05   1.57   2.09   2.62   3.14
fx >>
```

常用数学函数：abs, sqrt

Command Window

f_x >>

常用数学函数：abs, sqrt

Command Window

```
>> x = [-4 9 -16 25];
```

常用数学函数：abs, sqrt

Command Window

```
>> x = [-4 9 -16 25];
x =
     -4     9   -16    25
fx >>
```

常用数学函数：abs, sqrt

Command Window

```
>> x = [-4 9 -16 25];

x =

     -4     9   -16    25

>> y = abs(x)
```

常用数学函数：abs, sqrt

Command Window

```
>> x = [-4 9 -16 25];
x =
     -4     9   -16    25
>> y = abs(x)
y =
      4     9    16    25
fx >>
```

常用数学函数：abs, sqrt

Command Window

```
>> x = [-4 9 -16 25];
x =
     -4     9   -16    25
>> y = abs(x)
y =
      4     9    16    25
>> z = sqrt(y)
```

常用数学函数：abs, sqrt

Command Window

```
>> x = [-4 9 -16 25];
x =
     -4     9   -16    25
>> y = abs(x)
y =
      4     9    16    25
>> z = sqrt(y)
z =
      1     3     4     5
fx >>
```

常用数学函数: ceil, fix, floor, round

Command Window

f_x >>

常用数学函数: ceil, fix, floor, round

Command Window

```
>> x = [-1.6 -0.2 1.2 0.6];
fx >>
```

常用数学函数: ceil, fix, floor, round

Command Window

```
>> x = [-1.6 -0.2 1.2 0.6];
>> y = ceil(x)
```

常用数学函数: ceil, fix, floor, round

Command Window

```
>> x = [-1.6 -0.2 1.2 0.6];
>> y = ceil(x)
y =

     -1     0     2     1

fx >>
```

常用数学函数: ceil, fix, floor, round

Command Window

```
>> x = [-1.6 -0.2 1.2 0.6];
>> y = ceil(x)
y =
     -1     0     2     1
>> z = floor(x)
```

常用数学函数: ceil, fix, floor, round

Command Window

```
>> x = [-1.6 -0.2 1.2 0.6];
>> y = ceil(x)
y =

     -1     0     2     1

>> z = floor(x)
z =

     -2    -1     1     0

fx >>
```

常用数学函数: ceil, fix, floor, round

Command Window

```
>> x = [-1.6 -0.2 1.2 0.6];
>> y = ceil(x)
y =
     -1     0     2     1
>> z = floor(x)
z =
     -2    -1     1     0
>> g = fix(x)
```

常用数学函数: ceil, fix, floor, round

Command Window

```
>> x = [-1.6 -0.2 1.2 0.6];
>> y = ceil(x)
y =
     -1     0     2     1
>> z = floor(x)
z =
     -2    -1     1     0
>> g = fix(x)
g =
     -1     0     1     0
fx >>
```

常用数学函数: ceil, fix, floor, round

Command Window

```
>> x = [-1.6 -0.2 1.2 0.6];
>> y = ceil(x)
y =

     -1     0     2     1

>> z = floor(x)
z =

     -2    -1     1     0

>> g = fix(x)
g =

     -1     0     1     0

>> f = round(x)
```

常用数学函数: ceil, fix, floor, round

Command Window

```
>> x = [-1.6 -0.2 1.2 0.6];
>> y = ceil(x)
y =
     -1     0     2     1
>> z = floor(x)
z =
     -2    -1     1     0
>> g = fix(x)
g =
     -1     0     1     0
>> f = round(x)
f =
     -2     0     1     1
fx >>
```

基本语句

基本语句

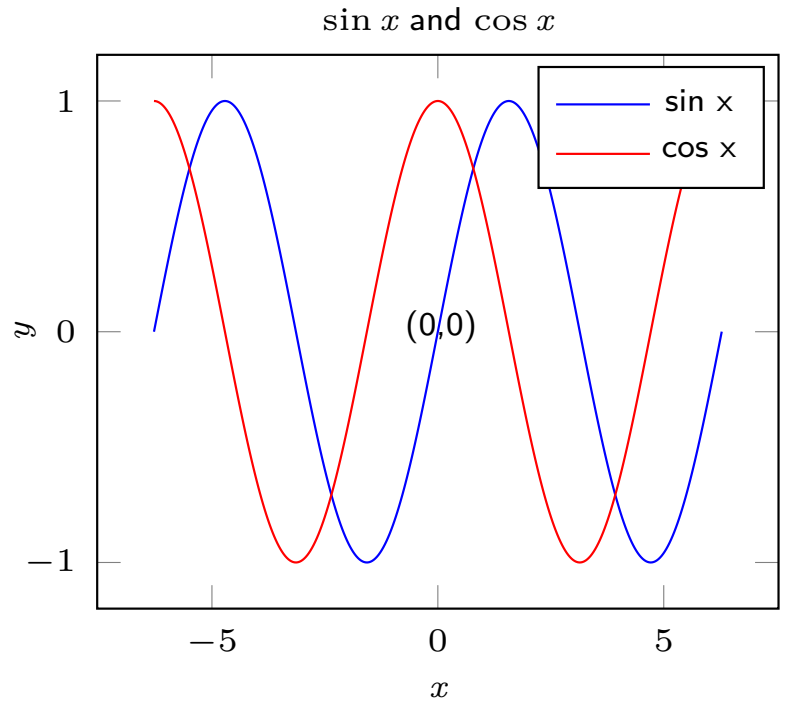
- for .. end
- if .. else .. end
- while .. end
- switch .. case .. end

举例: 求 1-10 以内的奇数和

```
1  % sum of the odd numbers between 1 and 10
2  x = 0;
3  for i = 1:10
4      if mod(i,2)
5          x= x + i;
6      end
7  end
```

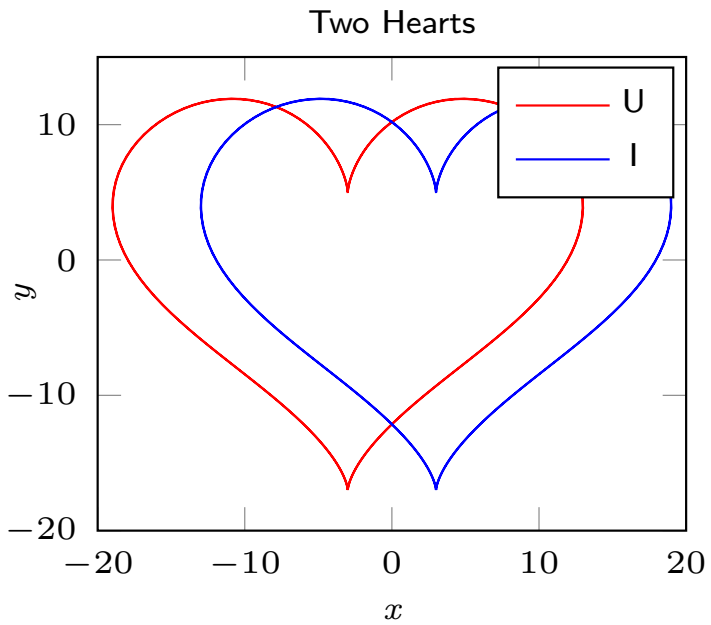
简单作图

```
1  x = -2*pi:0.1:2*pi;
2  y1 = sin(x);
3  y2 = cos(x);
4  plot(x, y1, '-b');
5  hold on
6  plot(x, y2, '-r');
7  xlabel('x')
8  ylabel('y')
9  text(0,0, '(0,0)')
10 legend('sin x', 'cos x')
```



简单作图

```
1  t = 0:pi/180:4*pi;
2  x = 16*sin(t).^3;
3  y = 13*cos(t)-5*cos(2*t)...
4      -2*cos(3*t)-cos(4*t);
5  plot(x-3,y,'-r', x+3,y,'-b');
6  xlabel('x');
7  ylabel('y');
8  axis([-20, 20, -20, 15]);
9  title('Two Heart')
10 legend('U', 'I')
```



简单作图

- 曲线图 plot: plot(x,y); plot(x,y,s), plot(x1,y1,s1,x2,y2,s2,...)

1	b	blue	.	point	-	solid
2	g	green	o	circle	:	dotted
3	r	red	x	x-mark	-.	dashdot
4	c	cyan	+	plus	--	dashed
5	m	magenta	*	star	(none)	no line
6	y	yellow	s	square		
7	k	black	d	diamond		
8	w	white	v	triangle (down)		
9			^	triangle (up)		
10			<	triangle (left)		
11			>	triangle (right)		
12			p	pentagram		
13			h	hexagram		

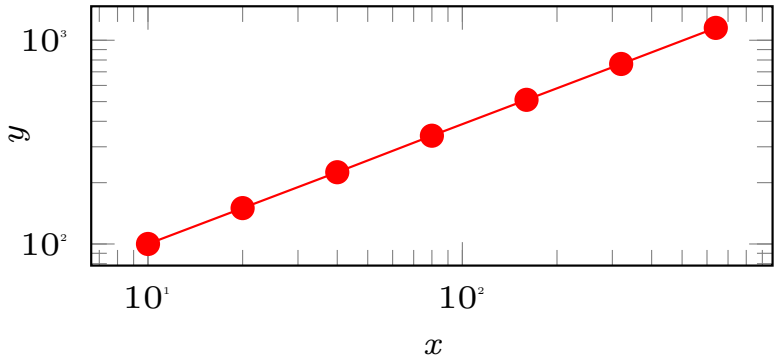
简单控制语句

- title(图形名称)
- xlabel(x 轴说明); ylabel(y 轴说明)
- text(x,y, 图形说明)
- legend(图例 1, 图例 2, ...)
- grid on / grid off / grid minor
- axis([xmin xmax ymin ymax]), xlim([xmin, xmax])

其它坐标系

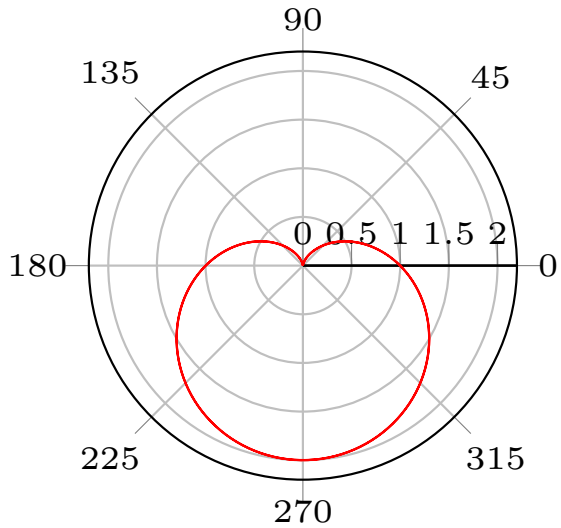
对数坐标: loglog, semilogx

```
1  x = 10*2.^[0:6];
2  y = [100 150 225 340 ...
3       510 765 1150];
4  loglog(x,y,'.-r')
5  xlim([0.5e1,0.8e3])
6  ylim([0.8e2,1.4e3])
7  xlabel('x'); ylabel('y')
```



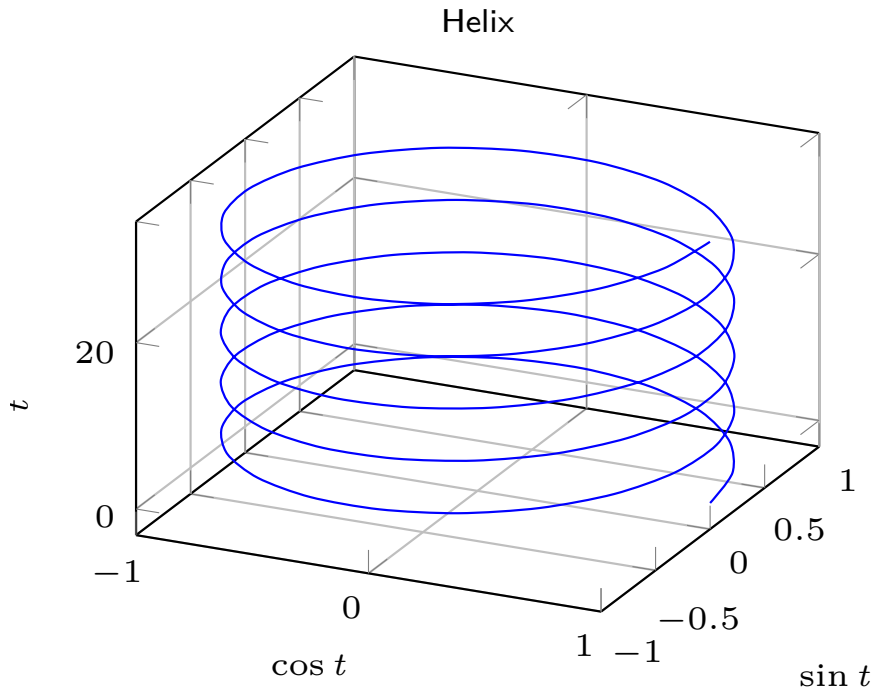
极坐标: polar

```
1  theta=0:pi/180:4*pi;
2  r=1-sin(theta);
3  polar(theta,r,'-r');
```



三维曲线图

```
1  t=0:pi/50:10*pi;
2  x = sin(t);
3  y = cos(t);
4  z = t;
5  plot3(x,y,z)
6  title('Helix')
7  xlabel('sin t')
8  ylabel('cos t')
9  zlabel('t')
10 grid on
```



三维曲面图: 补充函数 meshgrid

Command Window

$f_x >>$

$(1,1)$	$(2,1)$	$(3,1)$
$(1,2)$	$(2,2)$	$(3,2)$
$(1,3)$	$(2,3)$	$(3,3)$

2	1	2
1	0	1
2	1	2

$\sqrt{2}$	1	$\sqrt{2}$
1	0	1
$\sqrt{2}$	1	$\sqrt{2}$

三维曲面图: 补充函数 meshgrid

Command Window

```
>> [x, y] = meshgrid(1:3, 1:3)

x =

     1     2     3
     1     2     3
     1     2     3

y =

     1     1     1
     2     2     2
     3     3     3

fx >>
```

$(1,1)$	$(2,1)$	$(3,1)$
$(1,2)$	$(2,2)$	$(3,2)$
$(1,3)$	$(2,3)$	$(3,3)$

2	1	2
1	0	1
2	1	2

$\sqrt{2}$	1	$\sqrt{2}$
1	0	1
$\sqrt{2}$	1	$\sqrt{2}$

三维曲面图: 补充函数 meshgrid

Command Window

```
>> [x, y] = meshgrid(1:3, 1:3)

x =
     1     2     3
     1     2     3
     1     2     3
y =
     1     1     1
     2     2     2
     3     3     3

>> rsq = (x-2).^2 + (x-2).^2

rsq =
     2     1     2
     1     0     1
     2     1     2
fx >>
```

$(1,1)$	$(2,1)$	$(3,1)$
$(1,2)$	$(2,2)$	$(3,2)$
$(1,3)$	$(2,3)$	$(3,3)$

2	1	2
1	0	1
2	1	2

$\sqrt{2}$	1	$\sqrt{2}$
1	0	1
$\sqrt{2}$	1	$\sqrt{2}$

三维曲面图: 补充函数 meshgrid

Command Window

```
>> [x, y] = meshgrid(1:3, 1:3)

x =
     1     2     3
     1     2     3
     1     2     3
y =
     1     1     1
     2     2     2
     3     3     3

>> rsq = (x-2).^2 + (x-2).^2

rsq =
     2     1     2
     1     0     1
     2     1     2
>> r = sqrt(rsq)
r =
    1.4142    1.0000    1.4142
    1.0000         0    1.0000
    1.4142    1.0000    1.4142
```

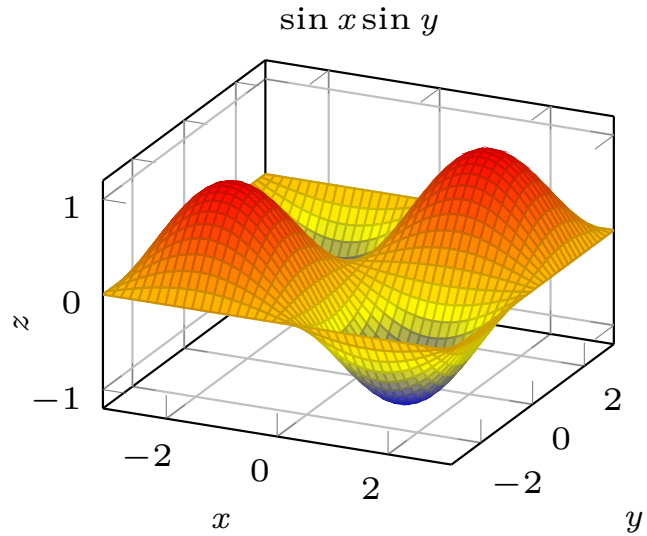
$(1,1)$	$(2,1)$	$(3,1)$
$(1,2)$	$(2,2)$	$(3,2)$
$(1,3)$	$(2,3)$	$(3,3)$

2	1	2
1	0	1
2	1	2

$\sqrt{2}$	1	$\sqrt{2}$
1	0	1
$\sqrt{2}$	1	$\sqrt{2}$

三维曲面图

```
1  [x,y] = meshgrid(-pi:0.1:pi);
2  z = sin(x).*cos(y);
3  mesh(x,y,z) % meshc(x,y,z)
4  surf(x,y,z) % surfc(x,y,z)
5  xlabel('x')
6  ylabel('y')
7  zlabel('z')
8  title('sin x sin y')
```



M 函数格式

M 函数格式

```
1  function [output 1, ..] = functionname(input1, ..)
2  % comment of this function
3
4  MatLab command 1;
5  MatLab command 2;
```

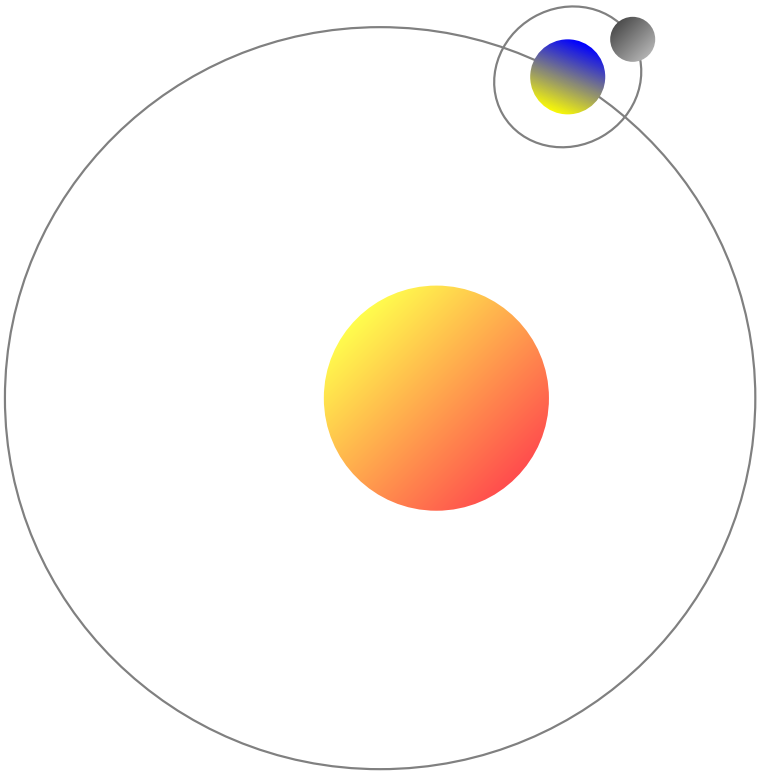
举例: 求矩形面积

```
1  function area = rectarea(L, W)
2  % rectarea  Area of a rectangle
3  %
4  %   rectarea(l, w) calculate the area of a rectangle
5  %   with a length of L and a width of W
6
7  area = L .* W
```

Part II

MatLab 编程实例

多体问题



考虑多个天体的系统 (比如“日地月”三天体系统), 求各个天体的运动规律.

- 天体间的距离远大于天体的尺寸, 所有天体都视为质点.
- 每个天体有固定质量, 并给出初始位置和初始速度.
- 任意两天体之间只有万有引力的作用.

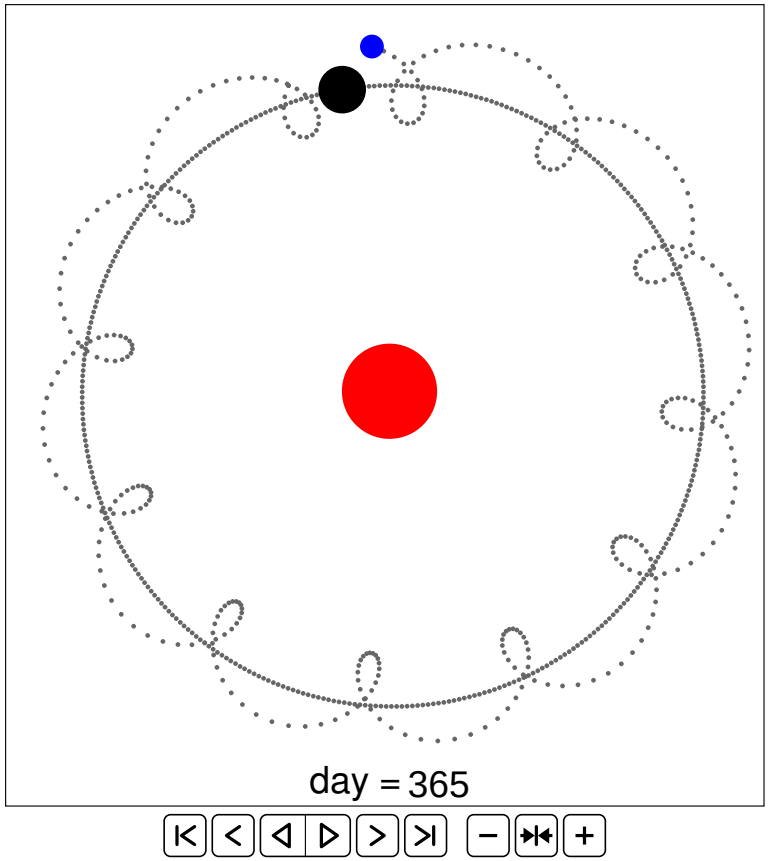
$$\mathbf{F_{ij}} = \frac{G m_i m_j}{r_{ij}^2} \hat{\mathbf{r}}_{\mathbf{ij}}$$

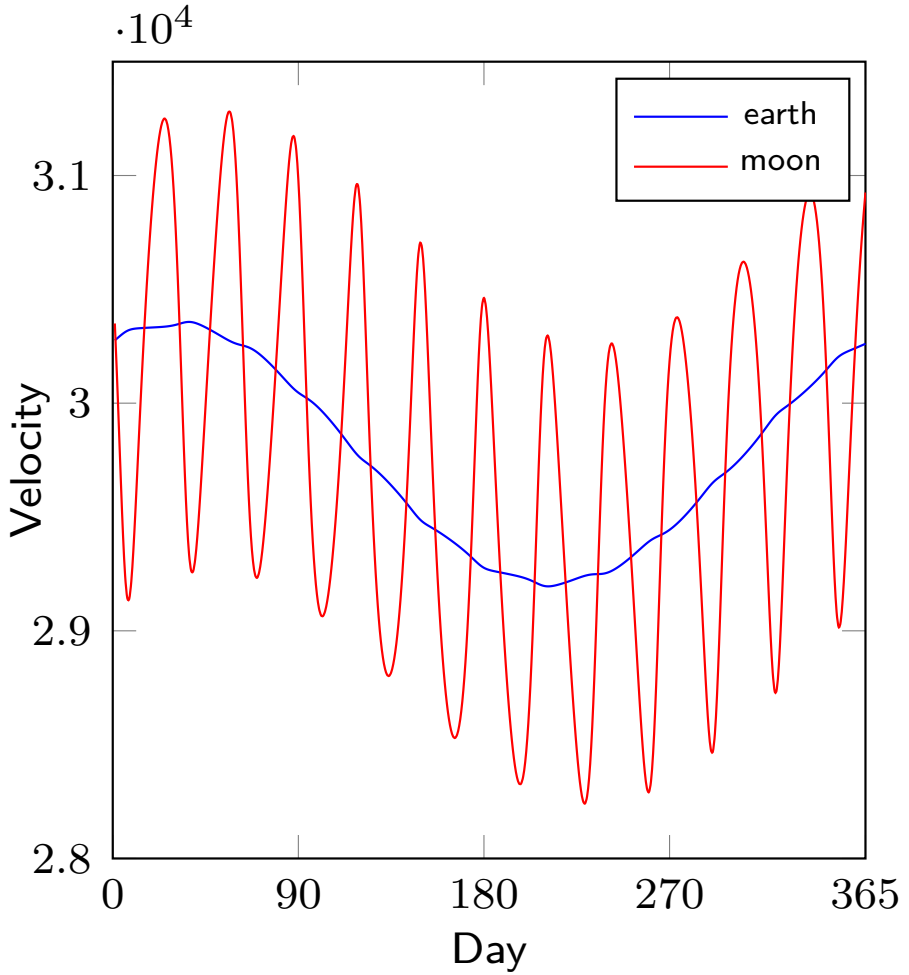
多体问题模拟程序

Matlab 程序: main.m

```
01 G = 6.67e-11;  dt = 24*3600;  N = 3;
02 M = [sun.mass    ; earth.mass    ; moon.mass    ];% N X 1
03 R = [sun.position; earth.position; moon.position];% N X 3
04 V = [sun.velocity; earth.velocity; moon.velocity];% N X 3
05 for t = 1:365
06     F = zeros(N,3);                  % F(i,:) = [fx, fy, fz]
07     for i = 1 : N
08         mi = M(i); ri = R(i,:);      % 第i个天体的质量和位置
09         for j = (i+1):N;
10             mj = M(j); rj = R(j,:);% 第j个天体的质量和位置
11             rij =  rj - ri;
12             fij = G*mi*mj./(norm(rij).^3).*rij;% 万有引力
13             F([i,j],:) = F([i,j],:) + [fij; -fij];
14         end
15     end
16     V = V + F./repmat(M,1,3)*dt;     % v(t+dt)=v(t)+a(t+dt)dt
17     R = R + V*dt;                    % r(t+dt)=r(t)+v(t+dt)dt
18 end
```

多体问题模拟结果


day = 365


$\cdot 10^4$
3.1
3
2.9
2.8
Velocity
0
90
180
270
365
Day
earth
moon

Thank You!!!