

第一讲: MatLab 基础

数学模型和算法的应用与 MATLAB 实现

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微信公众号: 超级数学建模

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Part I

MatLab 快速入门

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简介

简介, 界面和帮助
基本命令和语句
M 文件与 M 函数

简介
获得帮助

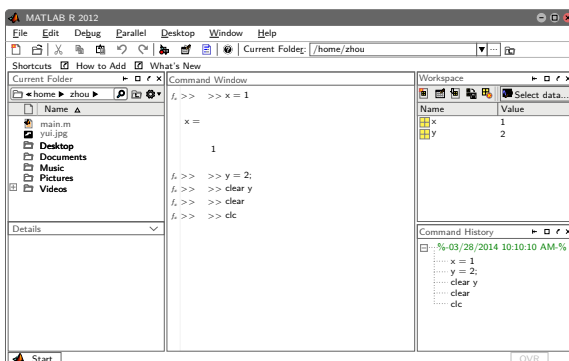
简史

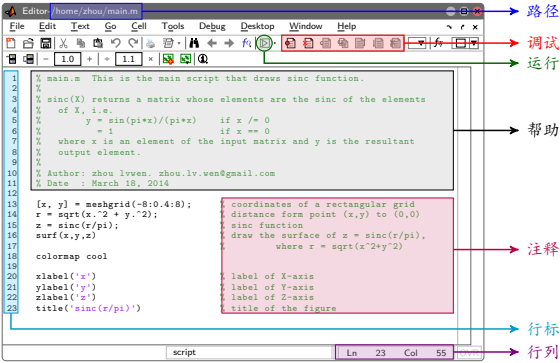
MATLAB (矩阵实验室) 是 **MAT**rix **LAB**oratory 的缩写;
最初由美国的 Clever Moler 教授于 1980 年开发, 初衷是为了解决“线性代数”课程的矩阵运算问题;
是一款由 MathWorks 公司 (1984 年成立) 出品的数学软件.

特性

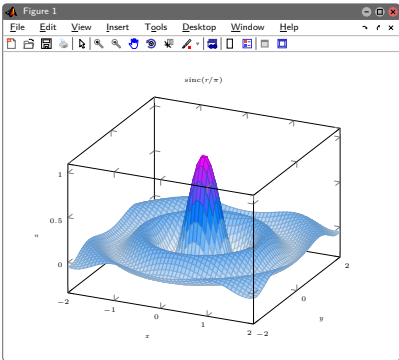
MATLAB 是一种用于算法开发, 数据可视化, 数据分析以及数值计算的高级技术计算语言和交互式环境.
MATLAB 可用来创建用户界面及调用其它语言编写的程序.
MATLAB 中包含众多的附加工具箱, 适合不同领域的应用.

主窗介绍





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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:

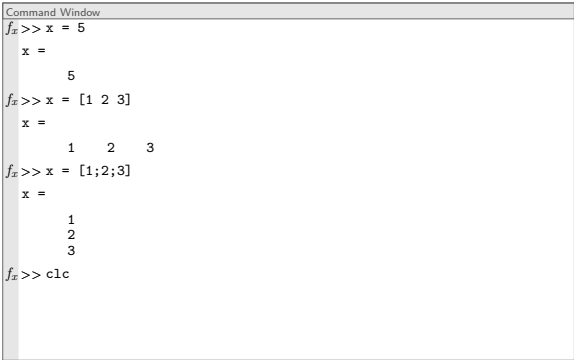
```
>> lookfor keyword
```

网络资源

Mathworks 文件交流中心: [Mathworks](#)

Github 代码托管网站: [Github](#)

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

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

fx>>
```

Notes

```
Command Window
fx>> x = [0:2]
x =
    0.00    1.00    2.00

fx>> x = [0:2]'
x =
    0.00
    1.00
    2.00

fx>> x = [0:0.5:2]
x =
    0.00    0.50    1.00    1.50    2.00

fx>> x = linspace(0, 2, 5)
x =
    0.00    0.50    1.00    1.50    2.00

fx>>
```

Notes

```
Command Window
fx>> x = zeros(2,3)
x =
    0.00    0.00    0.00
    0.00    0.00    0.00

fx>> y = ones(2)
x =
    1.00    1.00
    1.00    1.00

fx>> x = eye(2)
x =
    1.00    0.00
    0.00    1.00

fx>>
```

Notes

```
Command Window
fx>> pi
ans =
    3.1416

fx>> z = i
z =
    0.00 + 1.00i

fx>> x = 1/0
x =
    Inf

fx>> 0/0
ans =
    NaN

fx>>
```

Notes

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

C =

     2     5     8
    10    14     6
     9    12    15

fz>> D = A - B

D =

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

fz>> clc
```

Notes

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

E =

    19    33    23
    46    81    56
    73   129    89

fz>> F = A.* B

F =

     1     6    15
    24    45     0
    14    32    54

fz>> clc
```

Notes

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

G =

     0     0    0.50
   -3.00    0.00    3.50
   -6.00    0.00    6.50

fz>> H = A ./ B

H =

    1.00    0.67    0.60
    0.67    0.56    inf
    3.50    2.00    1.50

fz>> clc
```

Notes

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

I =

    30    36    42
    66    81    96
   102   126   150

fz>> J = A.^ 2

J =

     1     4     9
    16    25    36
    49    64    81

fz>> clc
```

Notes

```
Command Window
fj>> A = [1 2 3; 4 5 6; 7 8 9];
fj>> x = A(1, 3)
x =
    3
fj>> y = A(2, :)
y =
    4    5    6
fj>> z = A(1:2, 1:3)
z =
    1    2    3
    4    5    6
fj>>
```

Notes

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

Notes

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

Notes

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

Notes

数组操作函数: flipud, fliplr, rot90

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

A =

     7     8     9
     4     5     6
     1     2     3

fz>> C = rot90(A)

C =

     3     6     9
     2     5     8
     1     4     7

fz>>
```

数组操作函数: sum

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

ans =

     6

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

ans =

    12    15    18

fz>> sum(B,2)

ans =

     6
    15
    25

fz>>
```

数组操作函数: max, min

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

ans =

     3

fz>> max(A,2)

ans =

     2     2     3

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

ans =

     4     8     9

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

ans =

     9
     8
```

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

```
Command Window
fz>> x = 0:pi/6:pi;
x =

    0.00    0.52    1.05    1.57    2.09    2.62    3.14

fz>> y = sin(x)

y =

    0.00    0.50    0.87    1.00    0.87    0.50    0.00

fz>> z = asin(y)

z =

    0.00    0.52    1.05    1.57    2.09    2.62    3.14

fz>>
```

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

Notes

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

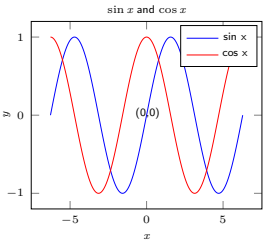
Notes

```
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
```

Notes

```
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')
```



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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
```

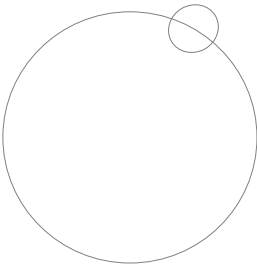
Part II

MatLab 编程实例

多体问题的模拟

问题
程序
结果

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.

$$\mathbf{F}_{ij} = \frac{Gm_i m_j}{r_{ij}^2} \hat{\mathbf{r}}_{ij}$$

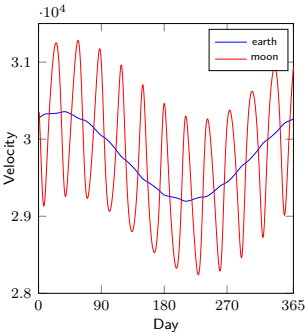
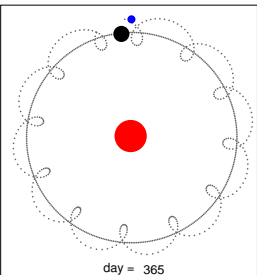
多体问题模拟程序

```
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
```

多体问题的模拟

问题
程序
结果

多体问题模拟结果



Thank You!!!

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