

中国科学技术大学 校园行

MATLAB®
& **SIMULINK®**



MATLAB官方微信公众号



MATLAB

MATLAB与数据分析

MathWorks

主要内容

- **MathWorks**
- **MATLAB 与矩阵计算**
- **MATLAB 数据分析**
- **DEMO**

MathWorks®



MathWorks是领先的为工程师和科学家提供数学计算软件的供应商。公司于1984年创立，总部位于美国马萨诸塞州内迪克，在全球15个国家有3500名员工



MathWorks公司



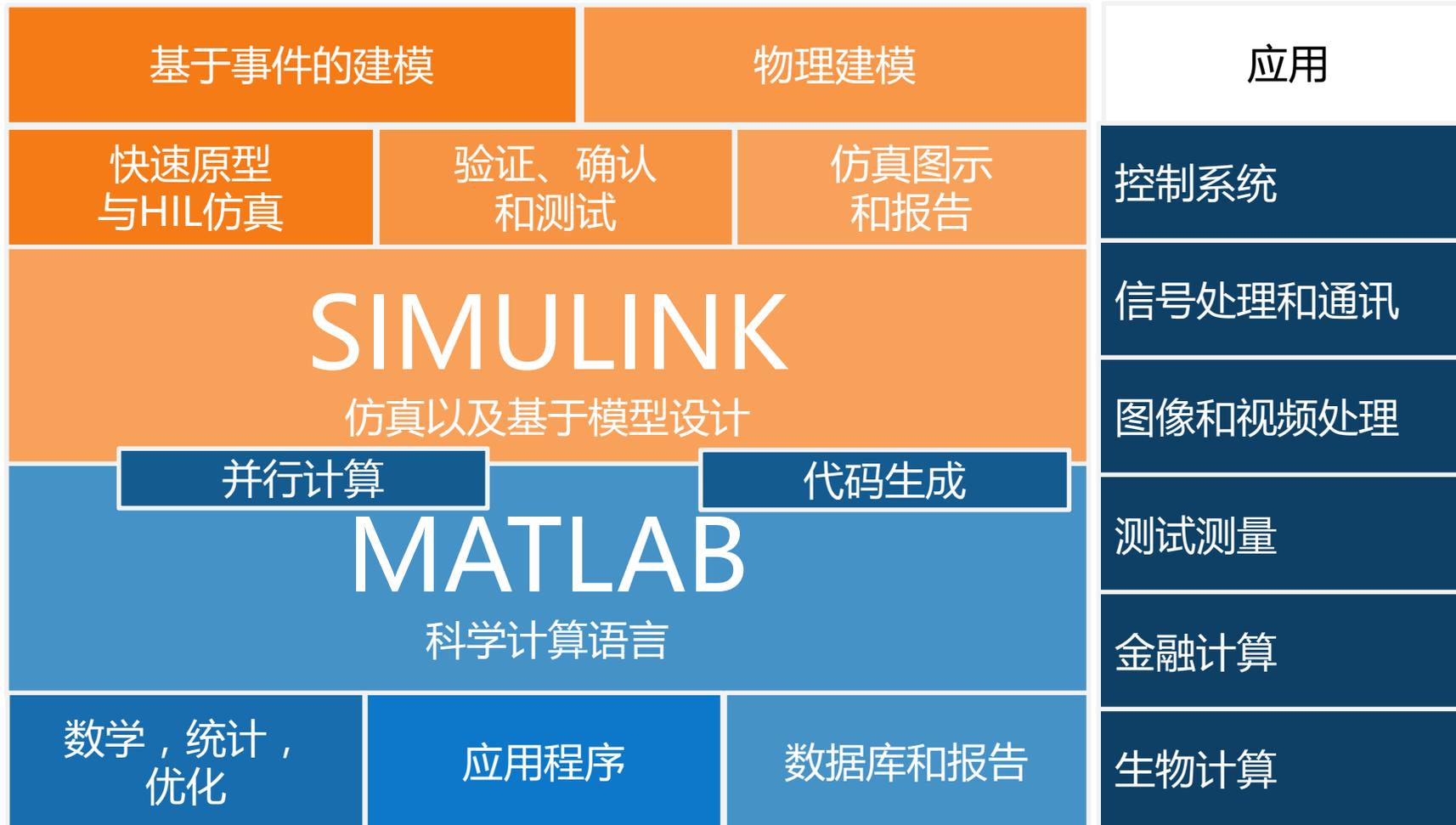
Earth's topography on a Miller cylindrical projection, created with MATLAB and Mapping Toolbox

- **公司总部:**
美国马萨诸塞州Natick市
- **美国分支机构:**
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- **亚太分支机构:**
澳大利亚/中国/印度/日本/韩国
- 全球培训和咨询
- 超过20个国家有分销商

MATLAB 家族

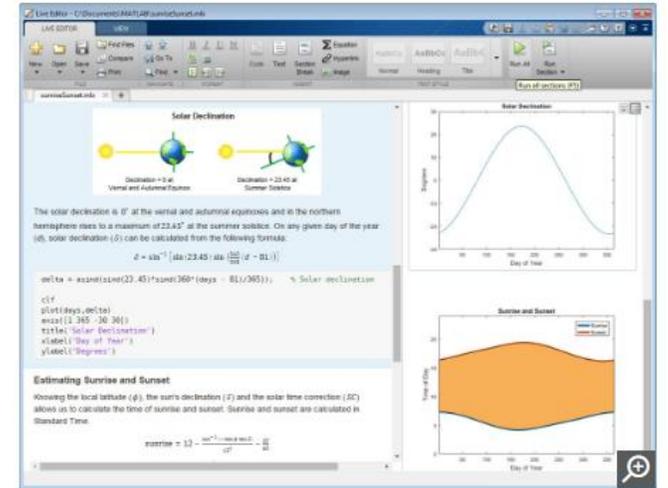
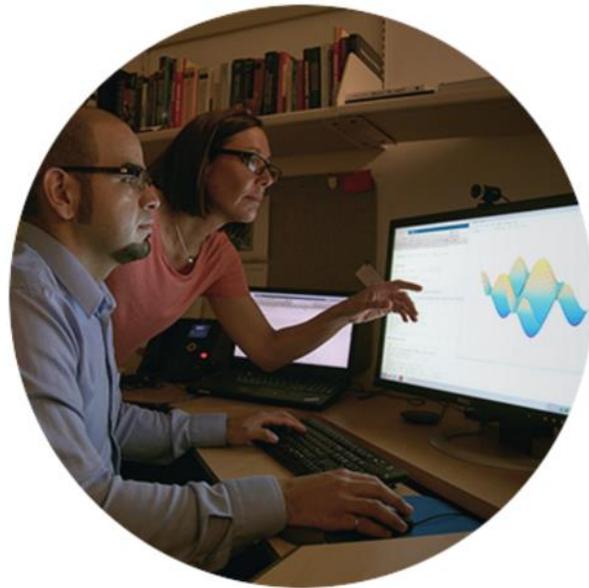
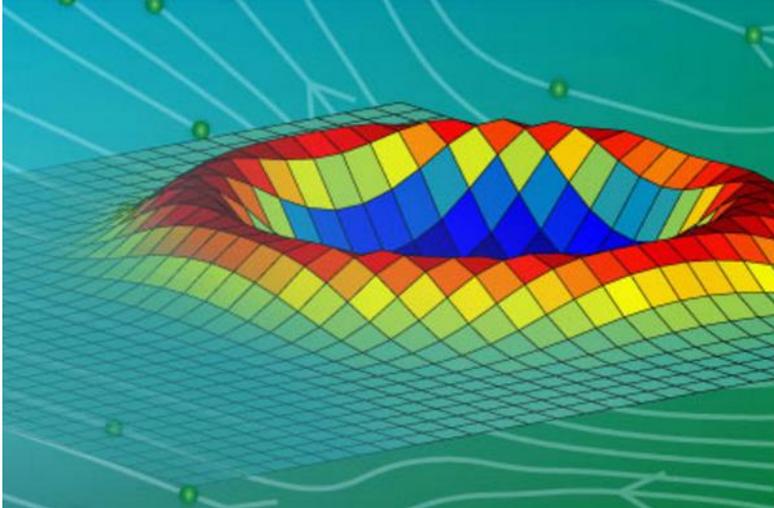
基于 MATLAB 和 Simulink 的近百种工具箱和扩展模块

正应用于当下的各行各业



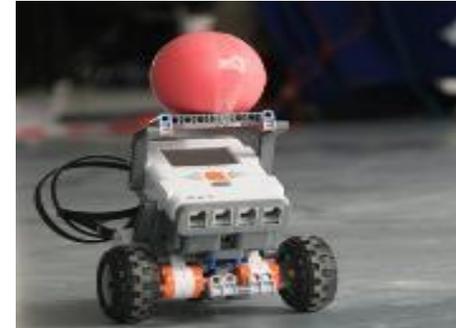
MATLAB是什么

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科学计算语言和编程环境。全球数以百万计的工程师和科学家使用 MATLAB® 来分析和设计可改变世界的系统和产品。



MATLAB应用领域

MATLAB 广泛应用于汽车主动安全系统、行星际宇宙飞船、健康监控设备、智能电网和 LTE 蜂窝网络。它用于机器学习、信号处理、图像处理、计算机视觉、通讯、计算金融学、控制设计、机器人学等等。

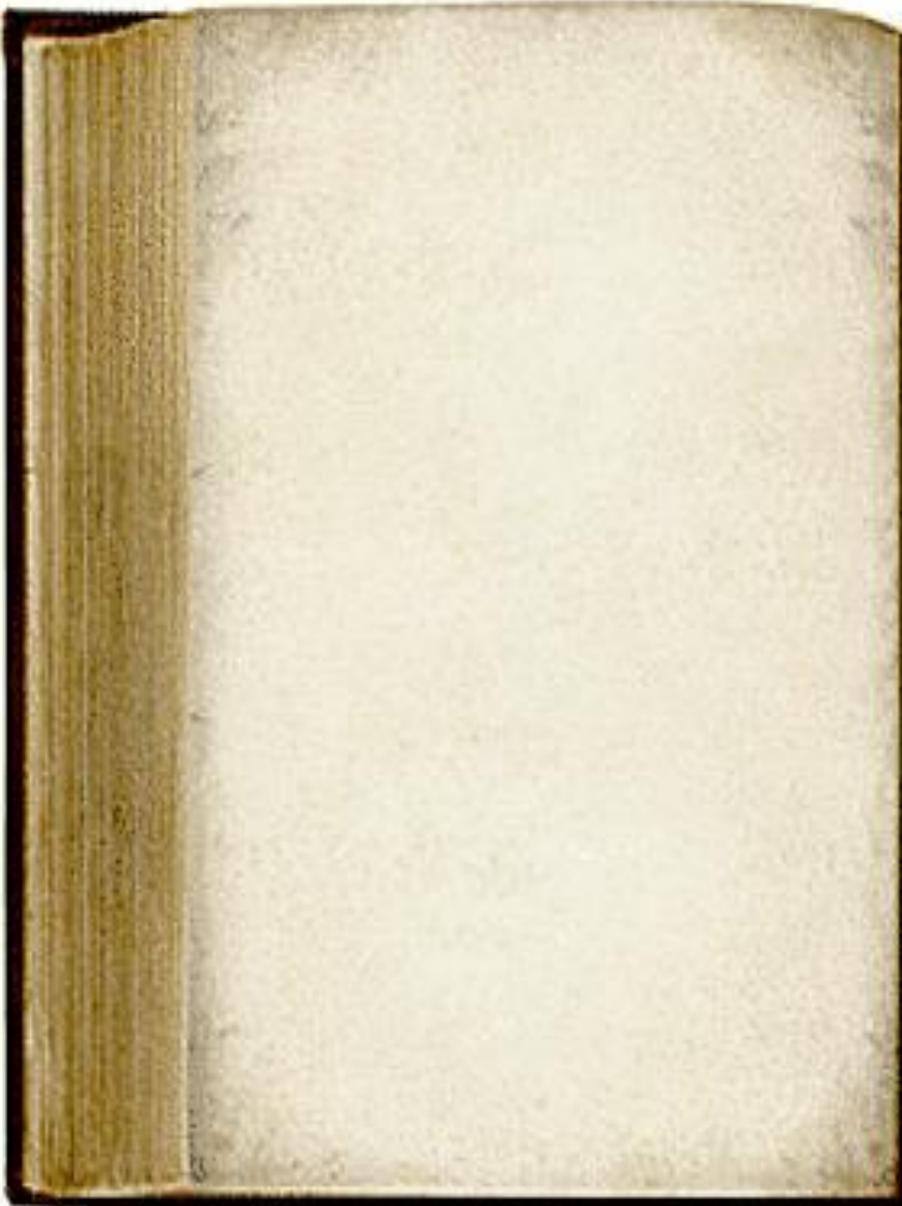


为什么是 MATLAB?

MATLAB

是工程师和科学家最易用、并且最高效的开发平台

1. MATLAB 是数学语言



```
%% Kalman Filter
% Predicted state and covariance
Xp = F*Xe;
Pp = F*Pe*F' + Q;

% Estimation
S = H*Pp'*H' + R;
B = H*Pp';
K = (S\B)';

% Estimated state and covariance
Xe = Xp+K*(z-H*Xp);
Pe = Pp-K*H*Pp;

% Estimated measurements
y = H*Xe;
```

2. MATLAB 丰富的工具箱

The image shows the MATLAB R2016a interface with several toolboxes visible in the left-hand pane:

- MATLAB VECTOR FIELDS:** feather, compass
- FINANCE TOOLBOX PLOTS:** volarea
- IMAGE PROCESSING TOOLBOX PLOTS:** imtool
- SIGNAL PROCESSING TOOLBOX: SPECTRAL ESTIMATION:** psd, periodogram, pwelch, pburg, pcov, pmcov, pyul
- STATISTICS AND MACHINE LEARNING TOOLBOX PLOTS:** boxplot, probplot, qqplot, andrewsplot, glyphplot, control
- SYSTEM ID: NON-PARAMETRIC ANALYSIS:** spa

The main workspace shows a graph plot titled "Shortest path between nodes 28 and 35". The graph consists of 60 nodes arranged in a circular pattern, with a highlighted path connecting nodes 28 and 35.

The image shows the MATLAB Documentation page for "Automotive Adaptive Cruise Control Using FMCW and MFSK Technology".

Automotive Adaptive Cruise Control Using FMCW and MFSK Technology

This example shows how model of an automotive radar in Simulink for an adaptive cruise control (ACC) system, which is an important part of an advanced driver assistance system (ADAS). The example explores both single and multiple targets scenarios. It shows how FMCW and MFSK waveforms can be processed to estimate the range and speed of surrounding vehicles.

[Open This Example](#)

Available Example Implementations

This example includes three Simulink® models:

- FMCW Radar Range Estimation: [slexFMCWExample.slx](#)
- FMCW Radar Multiple Targets Range and Speed Estimation: [slexFMCWMultiTargetsExample.slx](#)
- Multiple Targets Range and Speed Estimation Using MFSK: [slexMFSKMultiTargetsExample.slx](#)

FMCW Radar Range Estimation

The following model shows an end-to-end FMCW radar system. The system setup is similar to the MATLAB Automotive Adaptive Cruise Control Using FMCW Technology example. The only difference is in this model the FMCW waveform sweep is symmetric around the carrier frequency.

FMCW Radar Range Estimation

The diagram shows a Simulink model for FMCW Radar Range Estimation. It includes blocks for FMCW, Transmitter, Platform, Radar Platform, Channel, and Receiver. The Receiver block outputs Radar Pos and Radar Vel. The Platform block outputs Pos and Vel. The Radar Platform block outputs Radar Pos and Radar Vel. The Channel block outputs y. The Receiver block outputs Radar Pos and Radar Vel. The Platform block outputs Pos and Vel. The Radar Platform block outputs Radar Pos and Radar Vel. The Channel block outputs y.

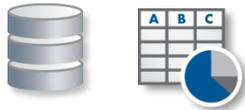
3. MATLAB 为工程学而设计

Access

Files

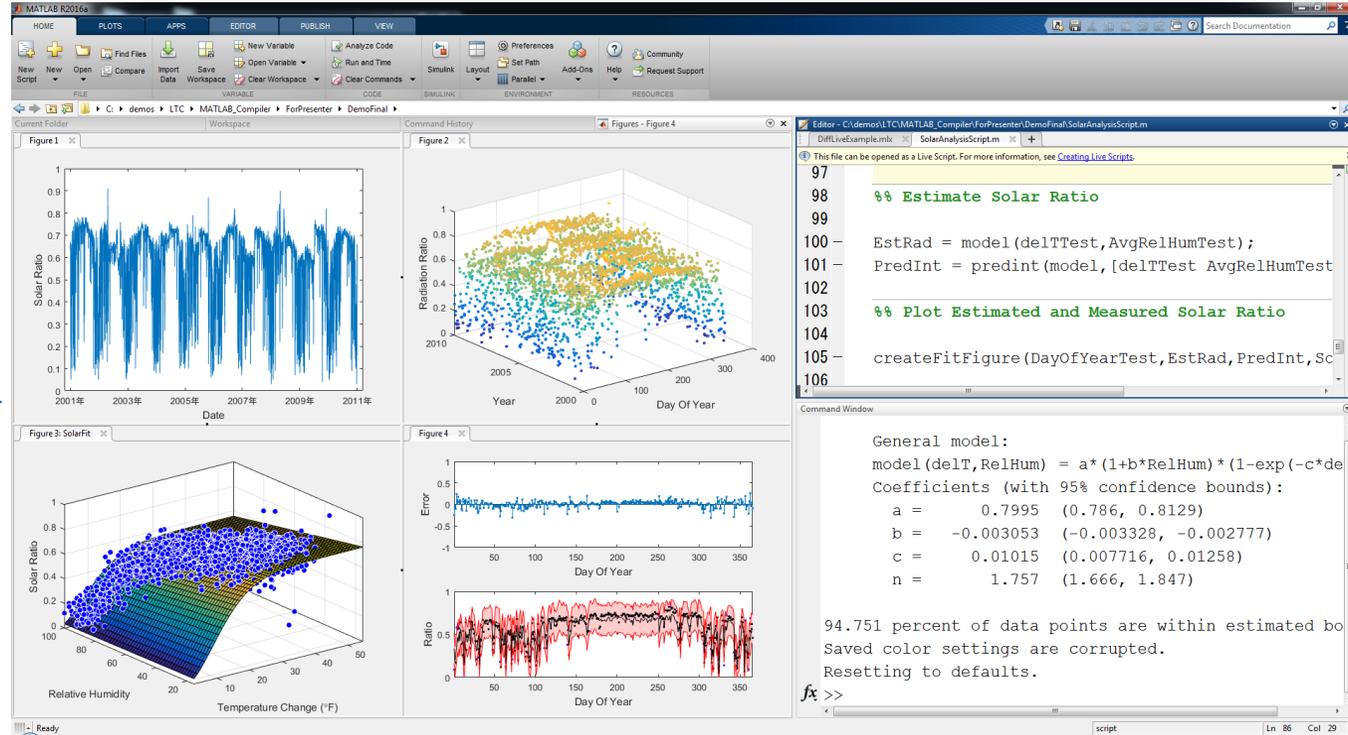
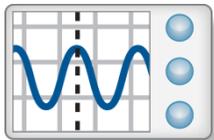


Software



Code & Applications

Hardware



Share

Reporting and Documentation



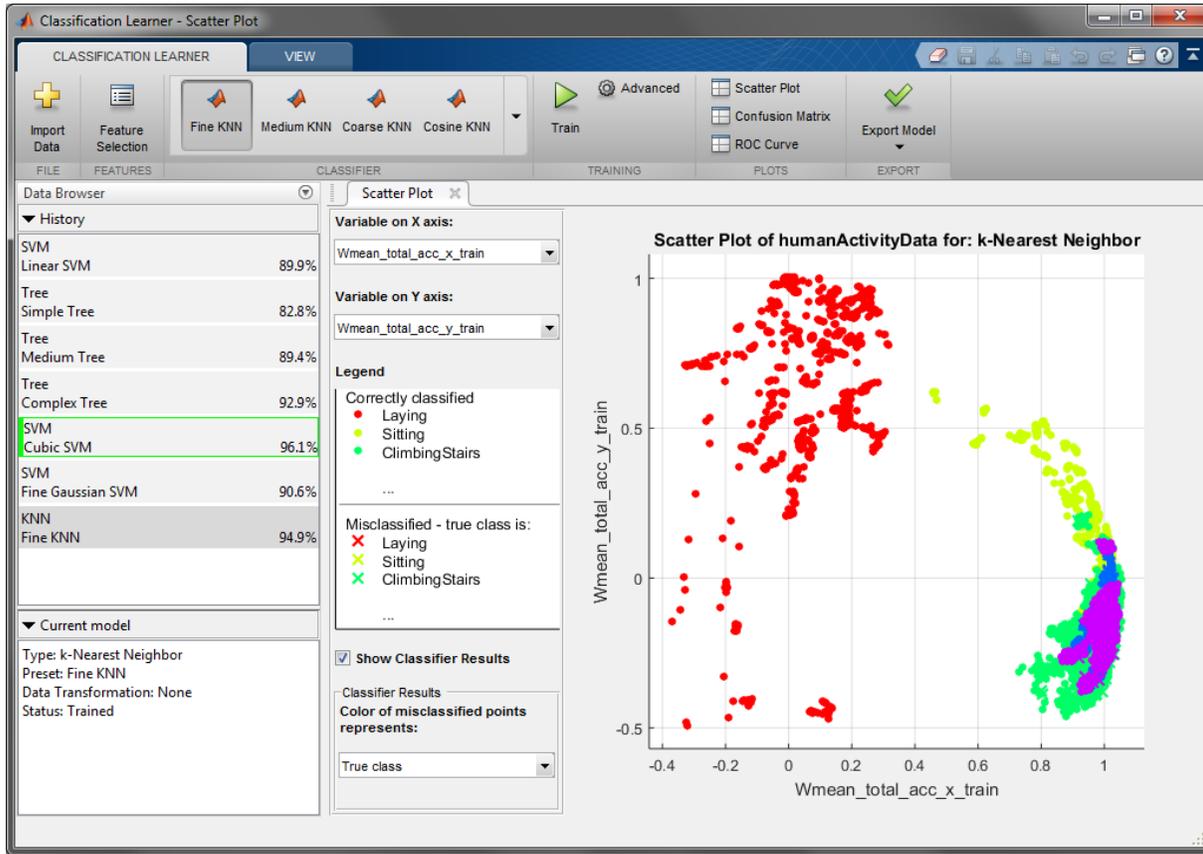
Outputs for Design



Deployment

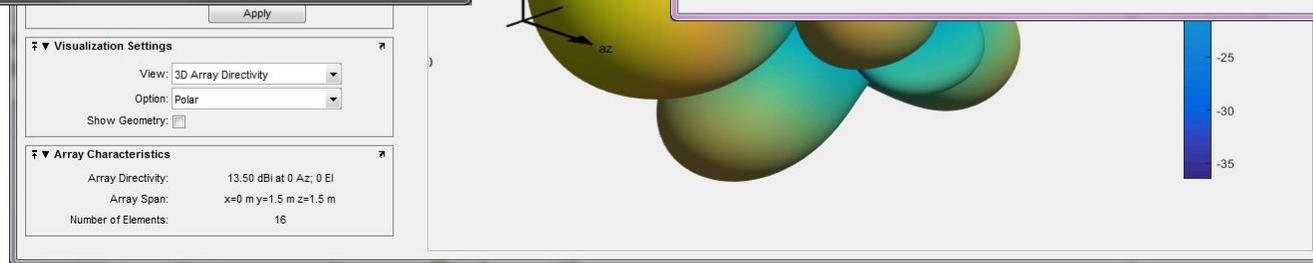
MATLAB Excel
.NET C/C++
.exe Java .dll

4. MATLAB 的 Apps

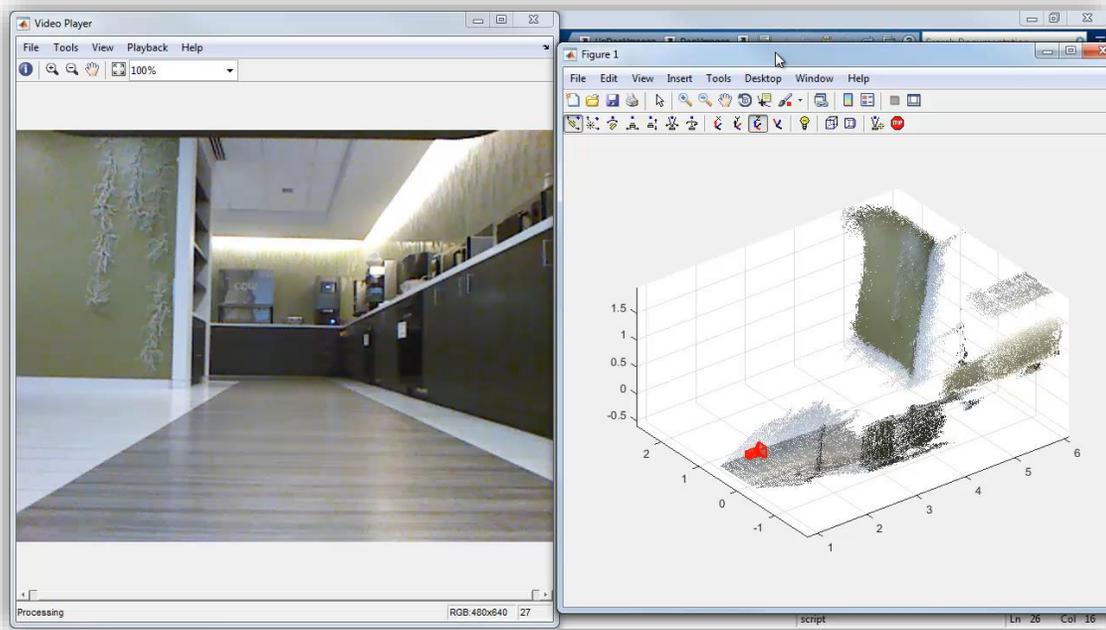


```

1 function [trainedClassifier, validationAccuracy] = trainClassifier(trainingData)
2 % trainClassifier(trainingData) ...
40
41 % Auto-generated by MATLAB on 29-Jan-2016 16:19:00
42
43
44 % Extract predictors and response
45 % This code processes the data into the right shape for training the
46 % classifier.
47 inputTable = trainingData;
48 predictorNames = {'SepalLength', 'SepalWidth', 'PetalLength', 'PetalWidth'};
49 predictors = inputTable(:, predictorNames);
50 response = inputTable.Species;
51 isCategoricalPredictor = [false, false, false, false]; %#ok<*NASGU>
52
53 % Train a classifier
54 % This code specifies all the classifier options and trains the classifier.
55 classificationKNN = fitcknn(...
56     predictors, ...
57     response, ...
58     'Distance', 'Euclidean', ...
59     'Exponent', [], ...
60     'NumNeighbors', 1, ...
61     'DistanceWeight', 'Equal', ...
62     'Standardize', true, ...
63     'ClassNames', {'setosa'; 'versicolor'; 'virginica'});
64
65 % Create the result struct with predict function
66 predictorExtractionFcn = @(t) t(:, predictorNames);
    
```



5. MATLAB 快速而高效



快速3D 数据并行计算

```

parfor m = 1:numel(freq)
    AR(m) = axialRatio(sp, freq(m), 0, 90);
    RL(m) = returnLoss(sp, freq(m));
end

```

```

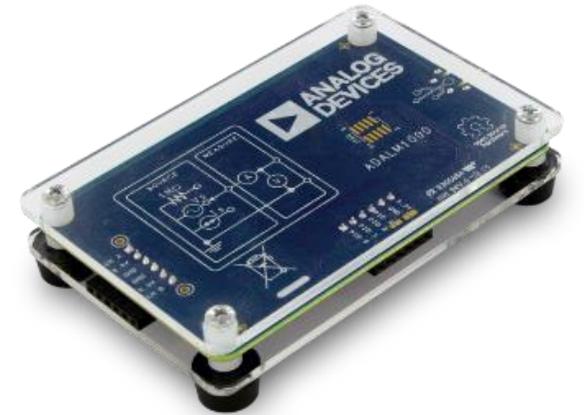
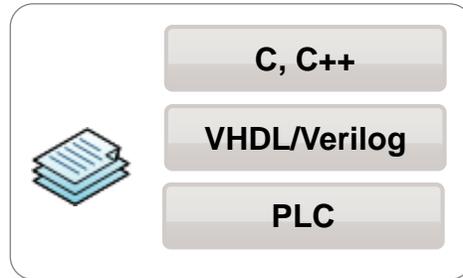
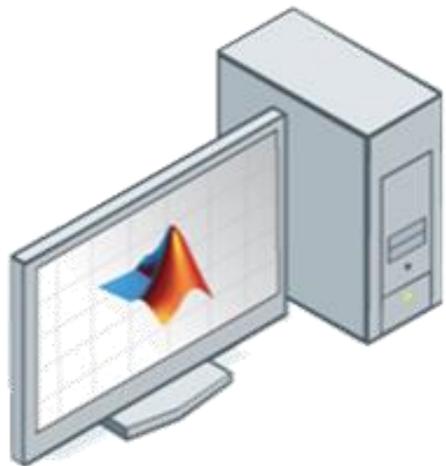
x = cos(pi*(0:N)/N);
x = gpuArray(x);
y = x';
dt = 6/N^2;
[xx,yy] = meshgrid(x,y);
vv = exp(-40*((xx-.4).^2 + yy.^2));

```

6. MATLAB 高度集成

1,000+ 款硬件器件

自动代码生成



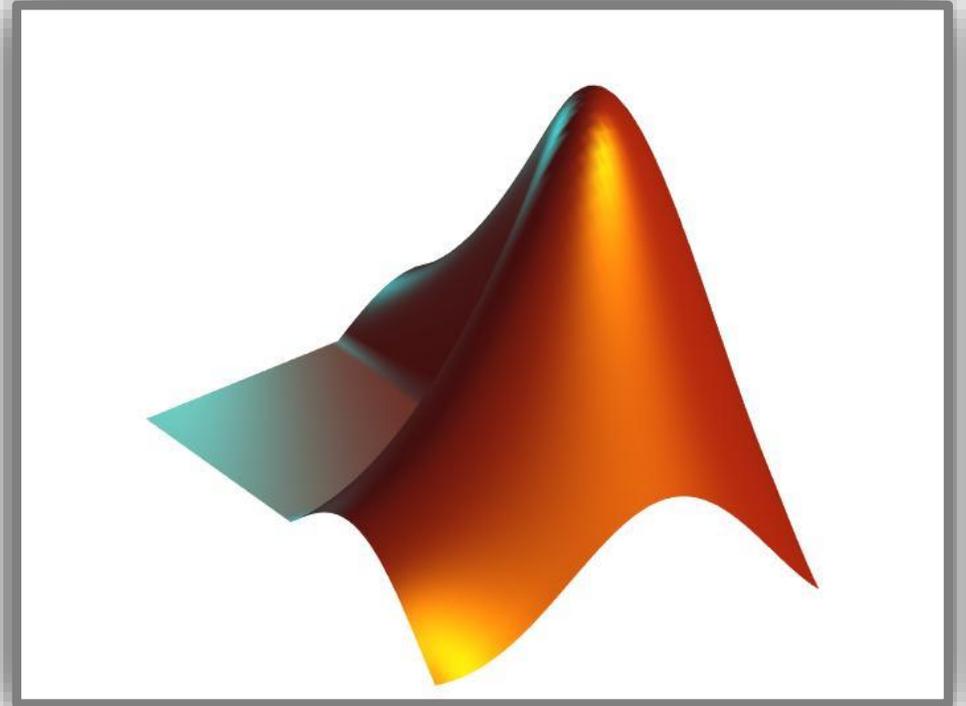
7. MATLAB 可信性



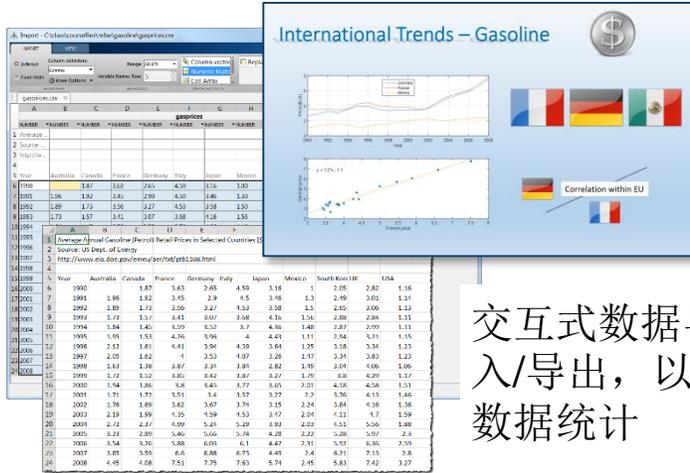
每天100- 200 万次测试

- 1. MATLAB 是数学语言**
- 2. MATLAB 丰富的工具箱**
- 3. MATLAB 为工程学而设计**
- 4. MATLAB 的 Apps**
- 5. MATLAB 快速而高效**
- 6. MATLAB 高度集成**
- 7. MATLAB 可信性**

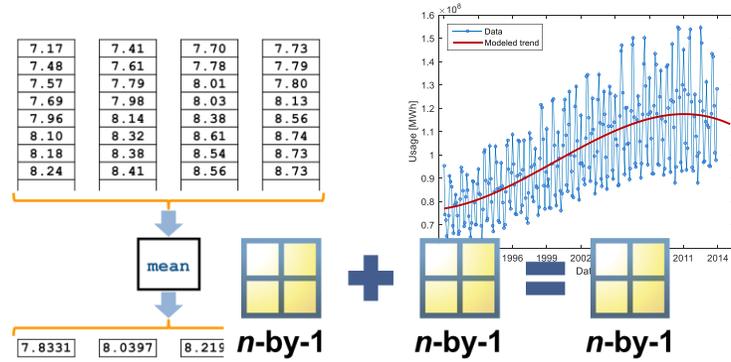
MATLAB与矩阵计算



MATLAB可以做什么?

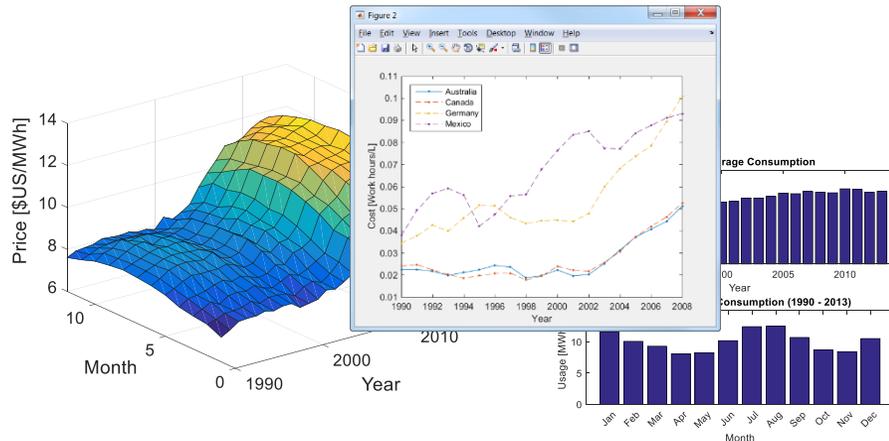


交互式数据导入/导出，以及数据统计

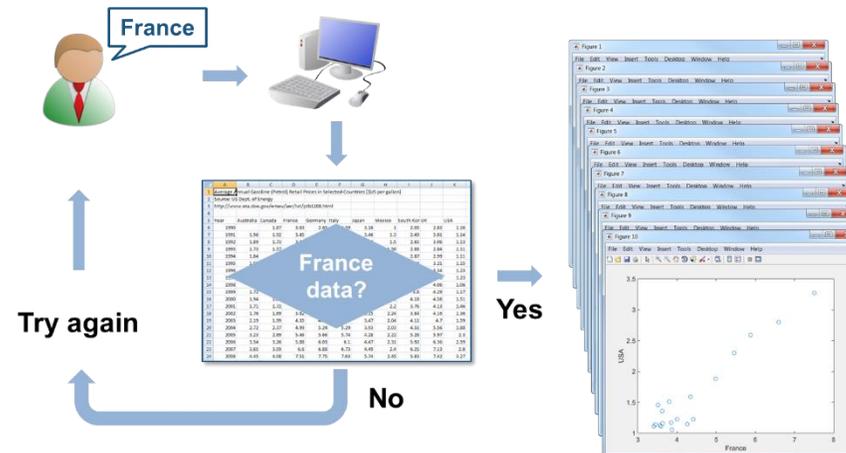


数据集合上的计算与分析

数据可视化



通过编写MATLAB代码自动完成复杂任务



MATLAB客户端界面

MATLAB R2017a - prerelease use

HOME PLOTS APPS EDITOR PUBLISH VIEW

MATLAB工具栏

显示MATLAB运行的当前路径

Current Folder

MATLAB运行的当前目录，可以点击查看目录内的文件或子目录

Editor - C:\Jobs\Statistics_and_Mathine_Learning\PredictiveMaintenance\5. PredictiveMaintenance\DataAnalytics4Predictiv...
DataAnalytics4PredictiveMaintenance.m

MATLAB代码编辑器。可以输入和运行MATLAB代码

```

66
67 %% Easily extract information from tables
68 x = trainFD001Unit1.Time;
69 y = trainFD001Unit1.HPCOutletTemp;
70 % interactive plot capabilities when selecting x and y
71
72 %% Interactive visualizations to aid discovery
73 figure;
74 for i = 1:9
75     h(i) = subplot(3,3,i);
76 end
77 figure;
78 for i = i+1:15
79     h(i) = subplot(3,2,i-9);

```

Workspace

Name	Value
file	'C:\Jobs\Statist
filename	'train_FD001_U
trainFD001Unit1	192x26 table

MATLAB工作空间 (workspace), 在此可以查看内存变量

Command Window

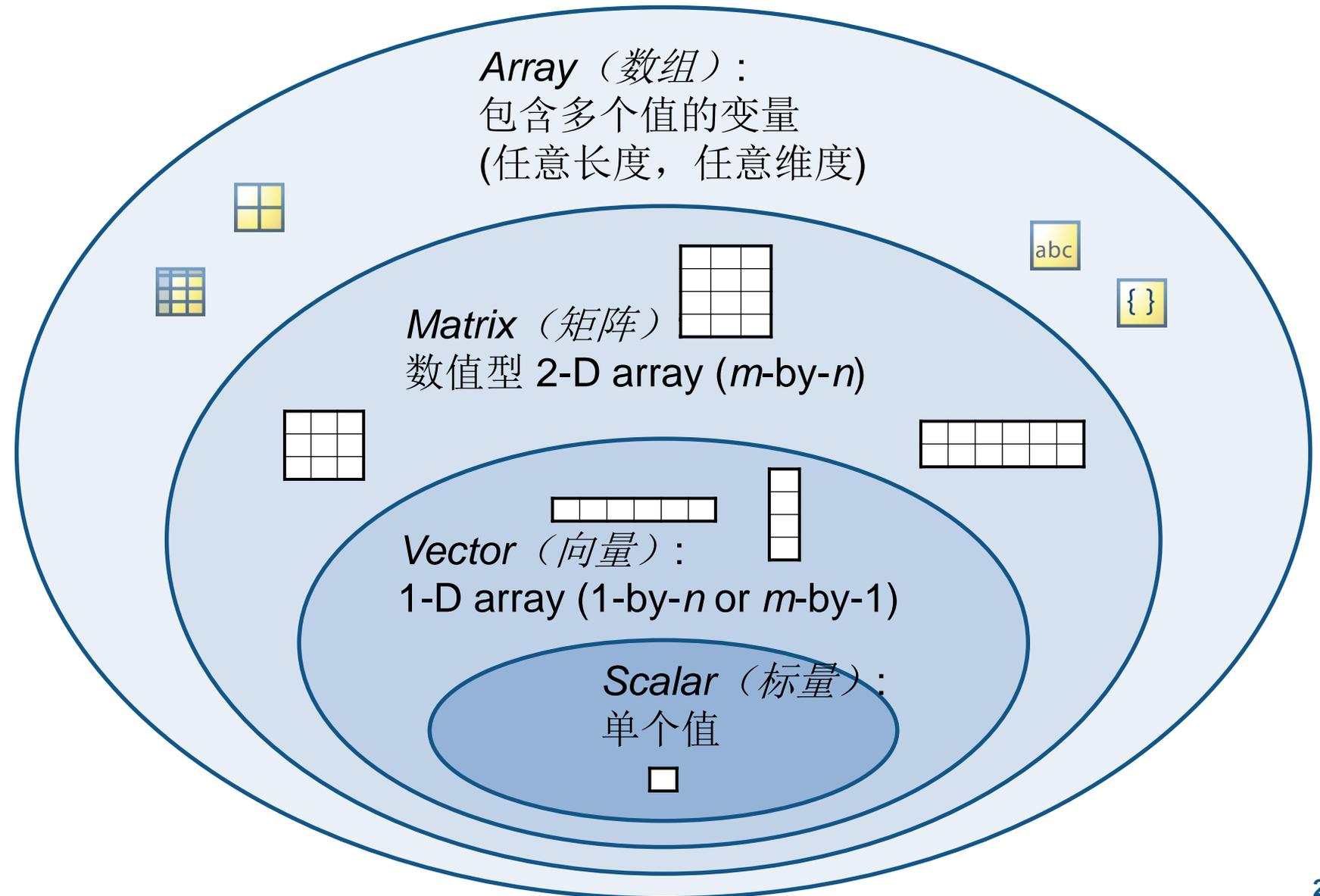
```

>>
>>
fx >>

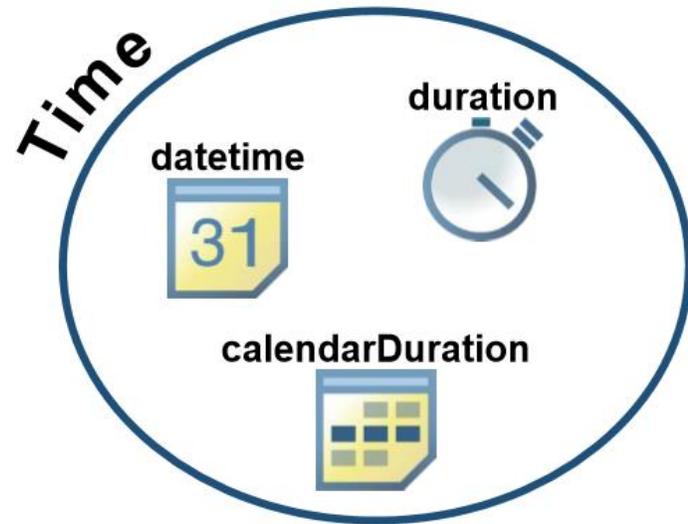
```

MATLAB命令行空间。可以运行MATLAB命令和函数

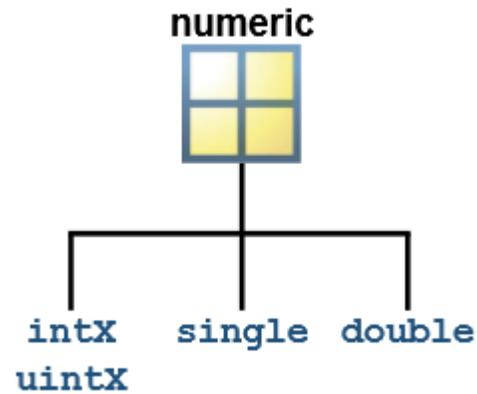
MATLAB中数据结构



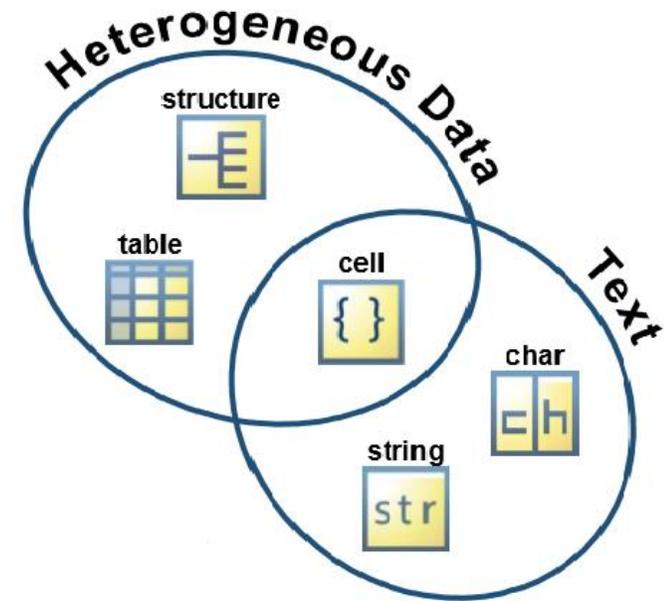
MATLAB中的数据类型



时间型



数值型



异构型和字符型



分类型



函数句柄型

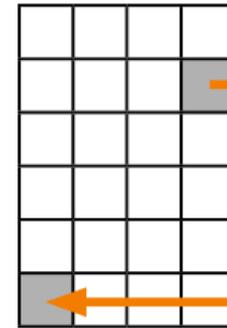
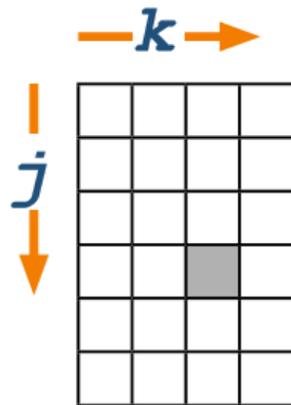


逻辑型

MATLAB矩阵计算

- 矩阵化的数据访问

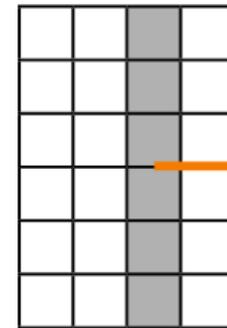
$A(j, k)$



$x = A(2, \text{end})$



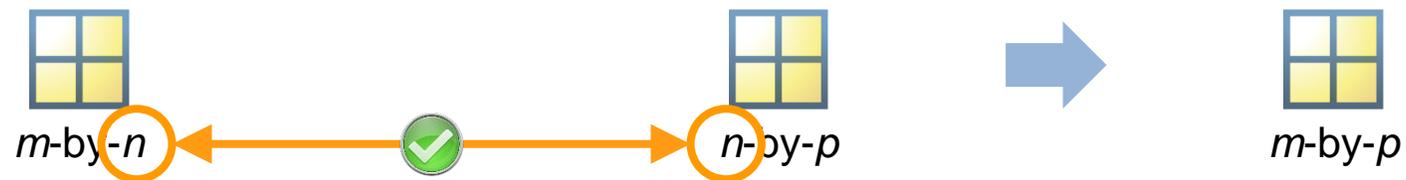
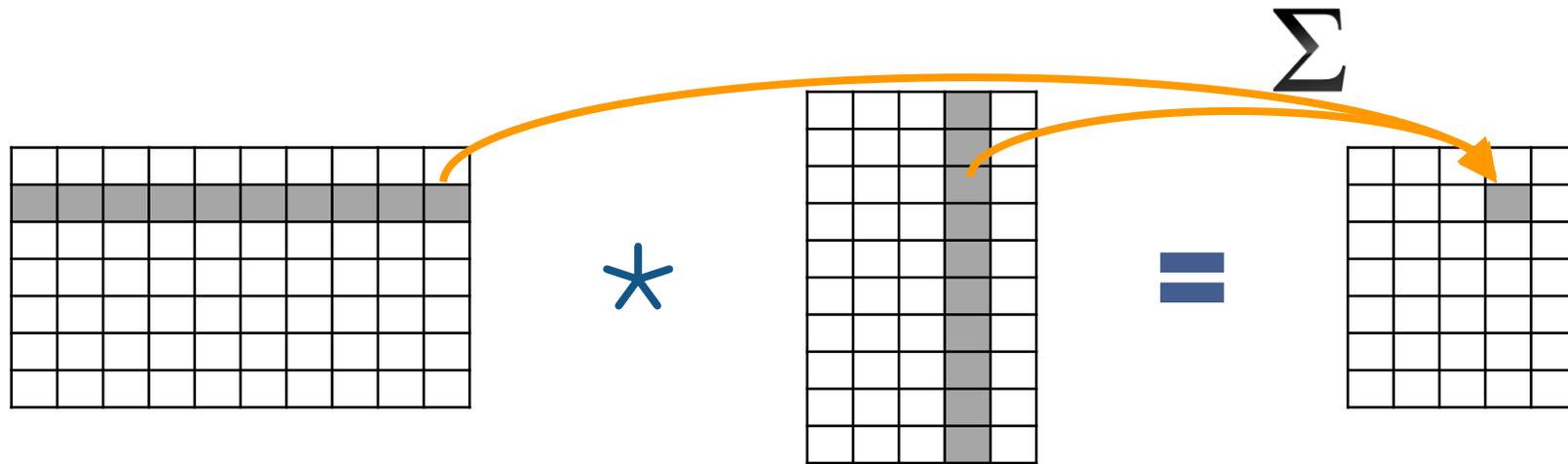
$A(\text{end}, 1) = x$



$x = A(1:6, 3)$
 $x = A(1:\text{end}, 3)$
 $x = A(:, 3)$

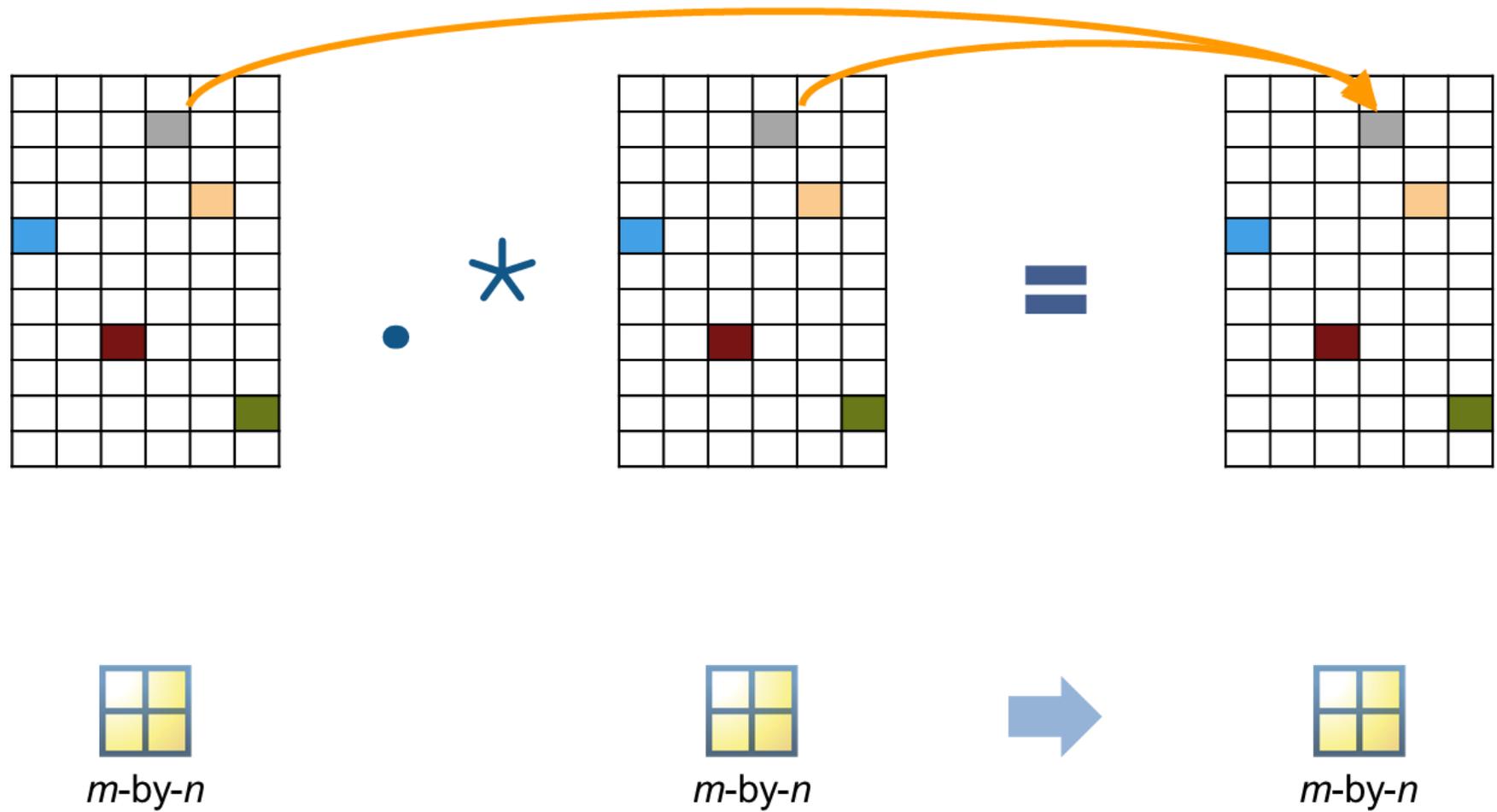
MATLAB矩阵计算

- 矩阵乘法



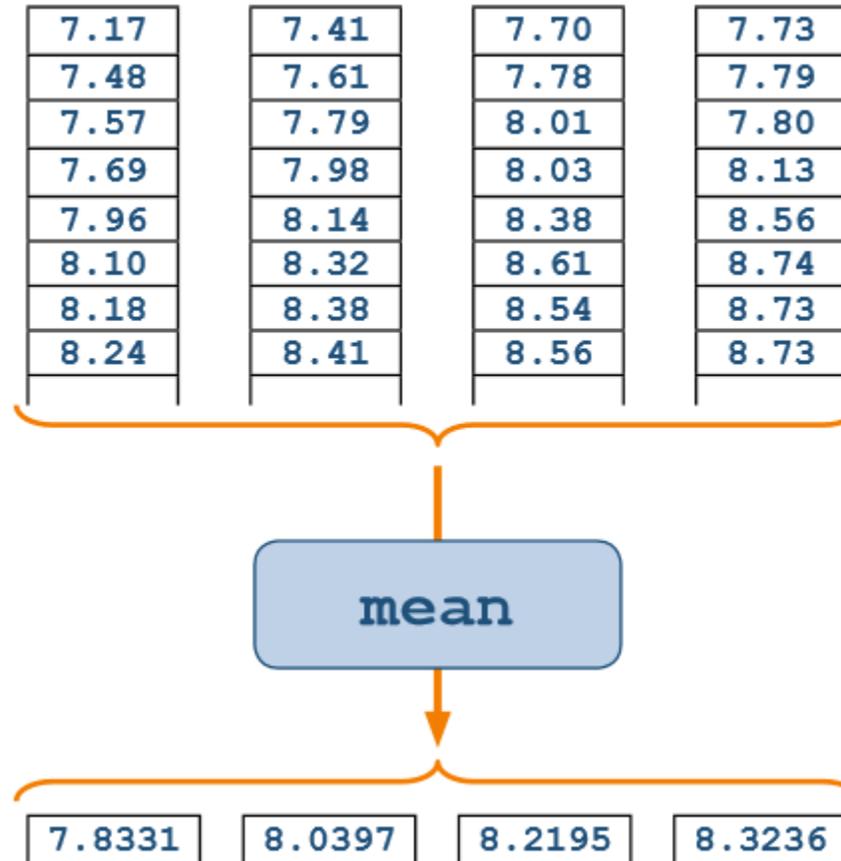
MATLAB矩阵计算

- 矩阵点乘法



MATLAB矩阵计算

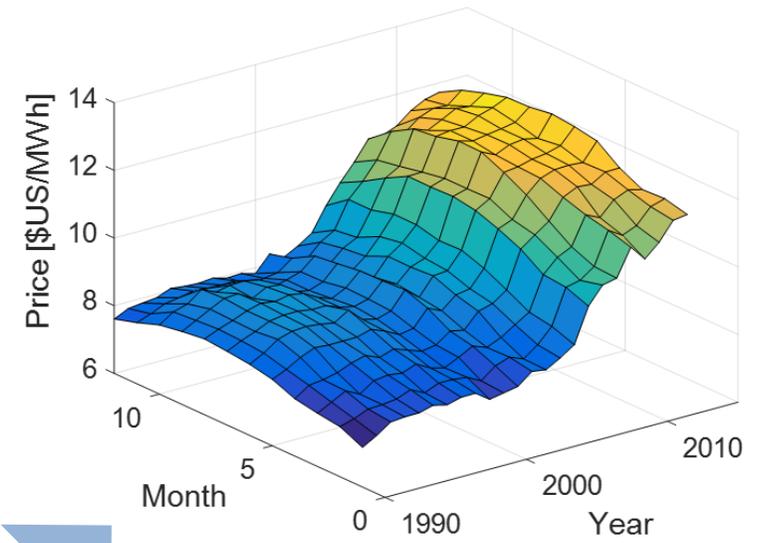
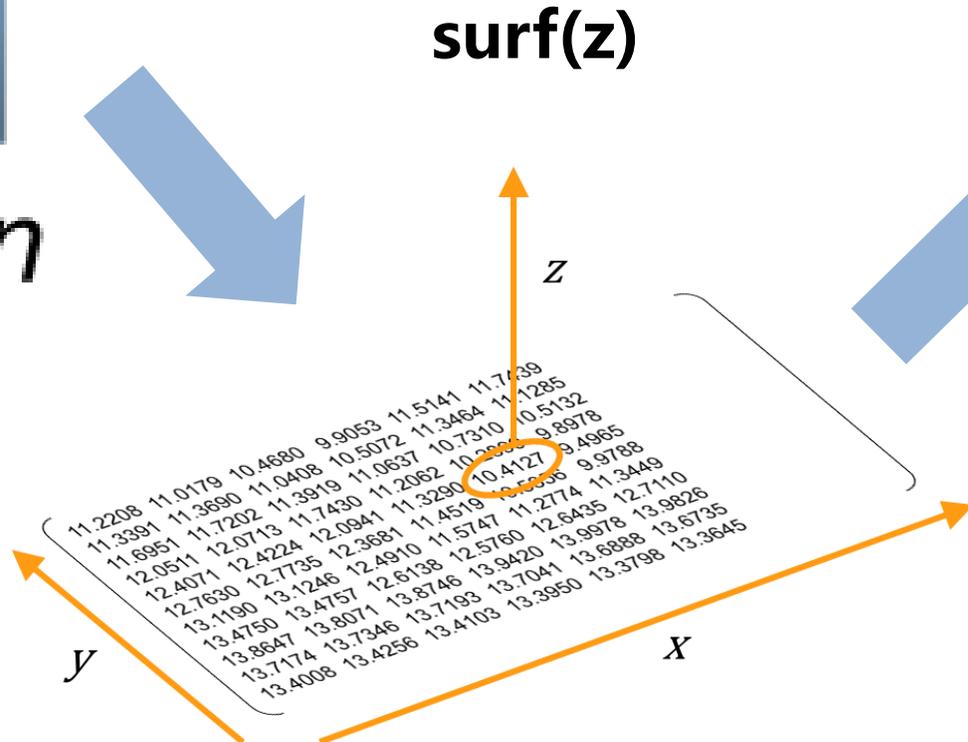
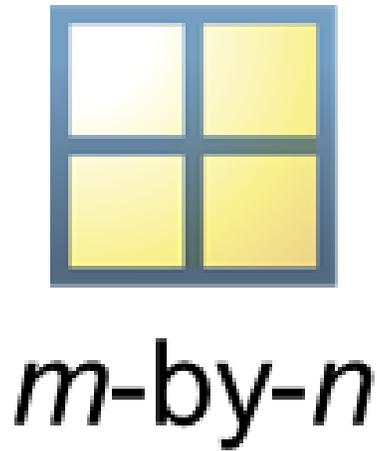
- 向量化操作的内置函数



```
sin  
sind  
sinh  
asin  
exp  
log  
log2  
log10  
sqrt  
nthroot  
abs  
angle  
floor  
ceil  
round  
mod  
max  
min  
mean  
median  
std  
sum  
prod  
diff  
gradient  
cumsum  
cumprod  
corrcoef  
cov
```

MATLAB矩阵计算

- 矩阵可视化



R2016a - 实时编辑器

Live Editor - C:\MATLAB\Live Editor\final_SunriseSunset.mlx

LIVE EDITOR VIEW

FILE NAVIGATE FORMAT INSERT TEXT STYLE RUN

```

clf
plot(days,delta)
axis([1 365 -30 30])
title('Solar Declination')
xlabel('Day of Year')
ylabel('Degrees')

```

Estimating Sunrise and Sunset

Knowing the local latitude (ϕ), the sun's declination (δ) and the solar time correction (SC) allows us to calculate the time of sunrise and sunset. Sunrise and sunset are calculated in Standard Time.

$$\text{sunrise} = 12 - \frac{\cos^{-1}(-\tan \phi \tan \delta)}{15^\circ} - \frac{SC}{60}$$

$$\text{sunset} = 12 + \frac{\cos^{-1}(-\tan \phi \tan \delta)}{15^\circ} - \frac{SC}{60}$$

```

sunrise = 12 - acosd(-tand(lat)*tand(delta))/15 - solarCorr/60;
sunset = 12 + acosd(-tand(lat)*tand(delta))/15 - solarCorr/60;

clf
plot(days, sunrise, days, sunset, 'LineWidth', 4)
axis([1 365 0 24])
title('Sunrise and Sunset')
xlabel('Day of Year')
ylabel('Time of Day')
legend('Sunrise', 'Sunset')
hold on
patch([days flip(days)], [sunrise flip(sunset)], [0.97 0.69 0.34])

```

The top plot shows the solar declination in degrees over the course of a year (Day of Year 1 to 365). The declination follows a sinusoidal wave, ranging from approximately -28 degrees to 28 degrees.

The bottom plot, titled "Sunrise and Sunset", shows the time of day (0 to 24 hours) for sunrise and sunset over the course of a year. The sunrise time (blue line) is lowest in winter and highest in summer, while the sunset time (orange line) is highest in summer and lowest in winter. The area between the two lines is shaded orange, representing the length of the day.

SolarAnalysis.mlx x FuelEconomy.mlx x SunriseSunset.mlx x final_SunriseSunset.mlx x +

帮助文档中文切换

Documentation

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< Language Fundamentals

< Matrices and Arrays

< MATLAB

< Functions

zeros

ON THIS PAGE

Syntax

Description

Examples

Input Arguments

More About

See Also

zeros

Create array of all zeros

Syntax

X = zeros

X = zeros(n)

X = zeros(sz1,...,szN)

X = zeros(sz)

X = zeros(__,typename)

X = zeros(__,'like',p)

Description

X = zeros returns the scalar 0.

X = zeros(n) returns an n-by-n matrix of zeros.

X = zeros(sz1,...,szN) returns an sz1-by-...-by-szN matrix.

X = zeros(sz) returns an array of zeros where size ve

X = zeros(__,typename) returns an array of zeros

the input arguments in the previous syntaxes.

Back	Alt+Left
Forward	Alt+Right
Find...	Ctrl+F
Zoom In	Ctrl+Plus
Zoom Out	Ctrl+Minus
Print...	Ctrl+P
Save As...	
Page Setup	
Get Page Address	

MathWorks® 产品 解决方案 教育 支持 社区 活动

文档 搜索最新文档

目录 关闭

< 文档主页

< MATLAB

< 语言基础知识

< 矩阵和数组

< 数组的创建和串联

< MATLAB

< MATLAB 函数

zeros

本页内容

语法

说明

示例

输入参数

详细信息

另请参阅

本页对应的英文页面已更新,但尚未翻译。若要查看最新内容,请点击此处访问英文页面。

zeros

创建全零数组

语法

X = zeros

X = zeros(n)

X = zeros(sz1,...,szN)

X = zeros(sz)

X = zeros(__,typename)

X = zeros(__,'like',p)

说明

X = zeros 返回标量 0。

X = zeros(n) 返回一个 n×n 的全零矩阵。

X = zeros(sz1,...,szN) 返回由零组成的 sz1×...×szN 数组,其中 sz1,...,szN 指示每个维度的

X = zeros(sz) 返回一个由零组成的数组,其中大小矢量 sz 定义 size(X)。例如, zeros([2 3])

Help Page Location

To view the installed version of this page in the Help browser, run this command:

web(fullfile(docroot, 'matlab/ref/zeros.html'))

To view this page at the MathWorks Web site, enter this URL in a Web browser:

<https://www.mathworks.com/help/releases/R2016b/matlab/ref/zeros.html> Go

You may be required to log in to your MathWorks Account to view this page on the Web.

Close Help

MATLAB数据分析

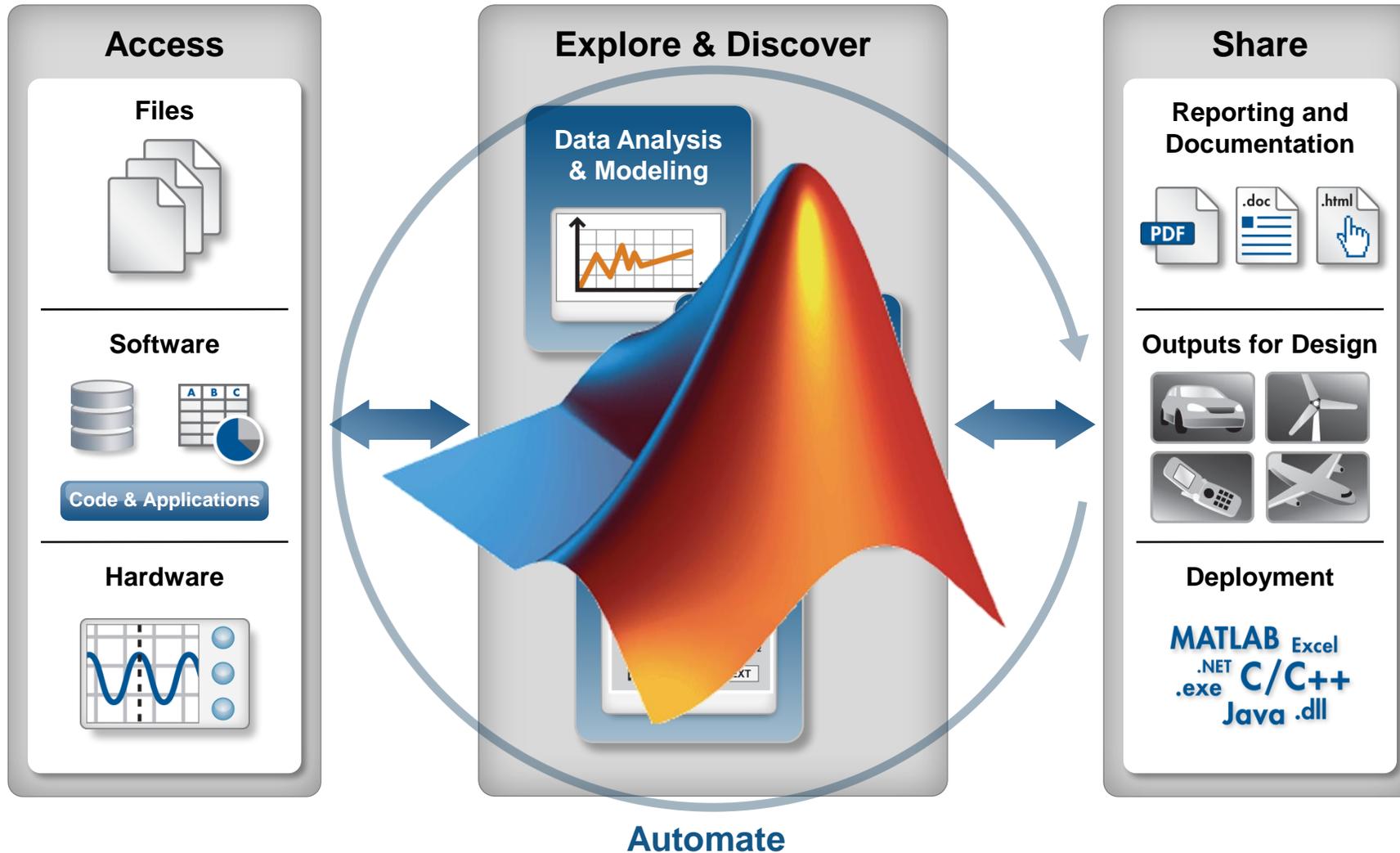


数据分析

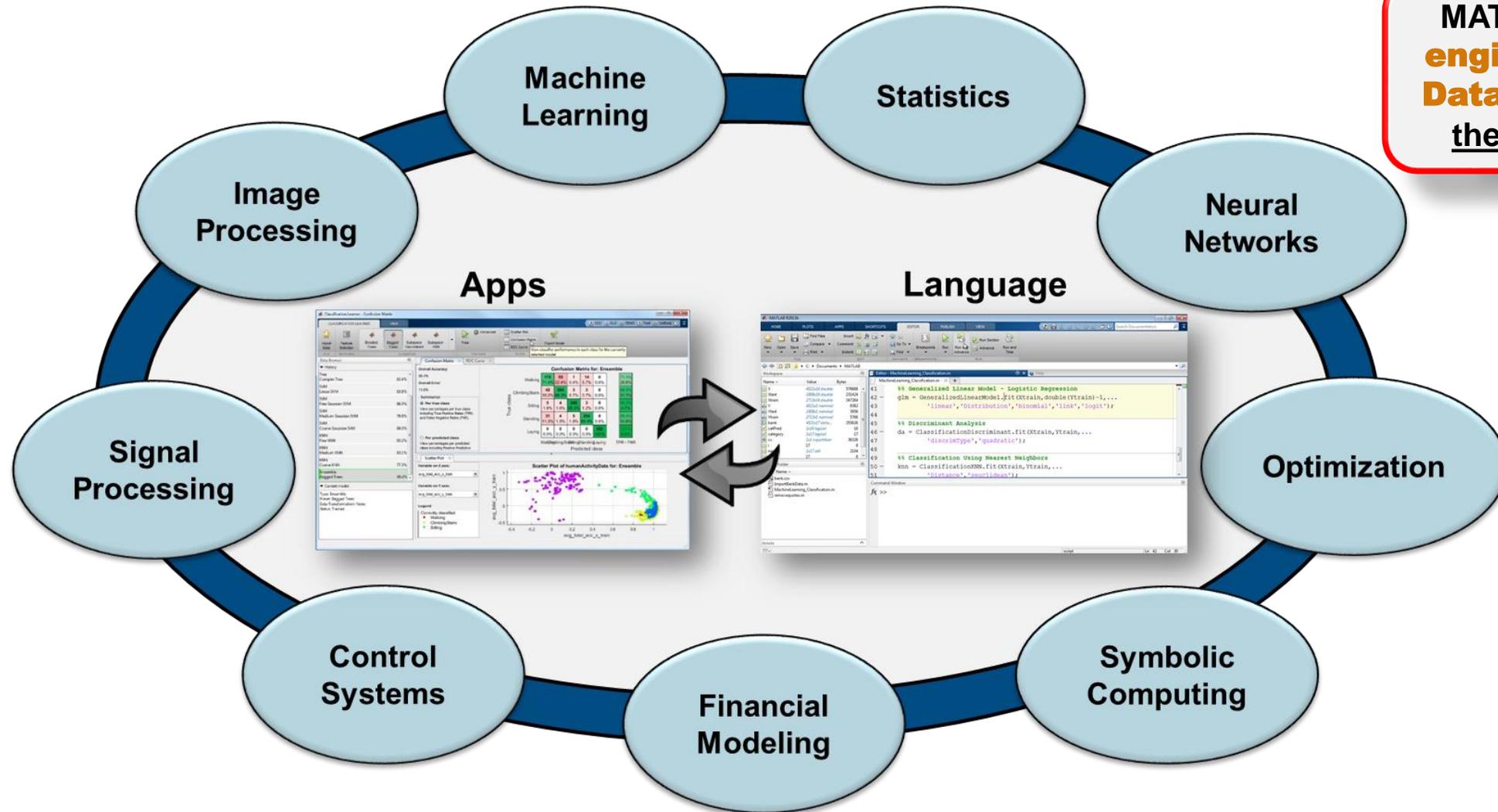
“Data analytics is a process of inspecting, cleaning, transforming, and modeling data with the goal of discovering useful information, suggesting conclusions, and supporting decision-making. ”

- - - *Wikipedia*

科学计算的开发流程

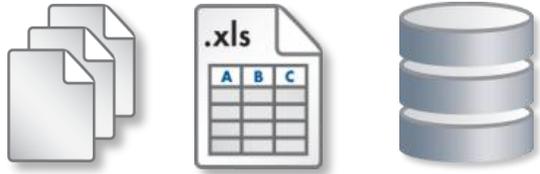


MATLAB 使得数据分析变得简单



MATLAB lets engineers do Data Science themselves

MATLAB支持多种数据源



文件访问

- Text
- Spreadsheet
- XML
- CDF/HDF
- Image
- Audio
- Video
- Geospatial/Maps
- Web content

数据库访问

- ODBC
- JDBC
- HDFS (Hadoop)



通信协议

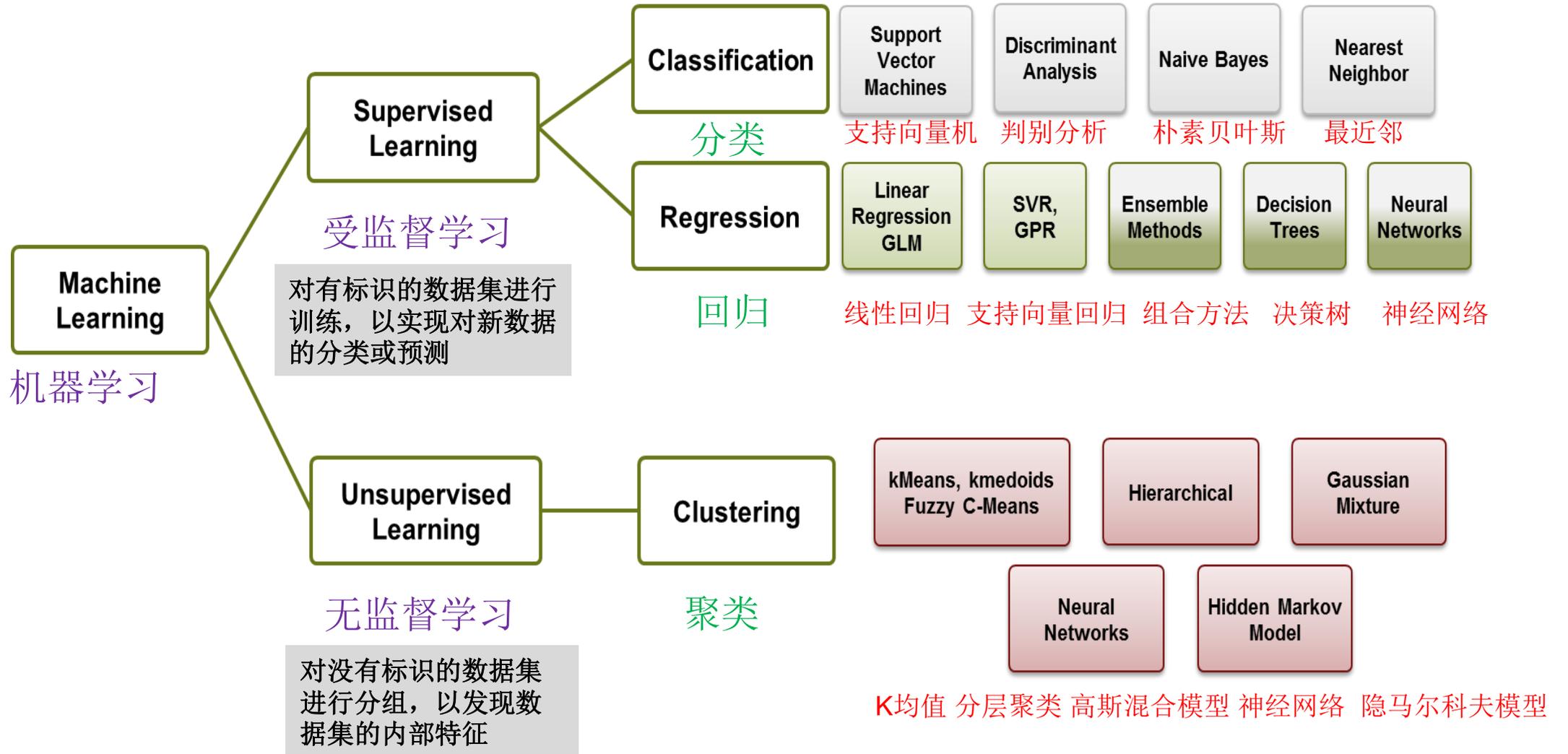
- CAN (Controller Area Network)
- DDS (Data Distribution Service)
- OPC (OLE for Process Control)
- XCP (eXplicit Control Protocol)
- TCP/IP
- I²C etc.



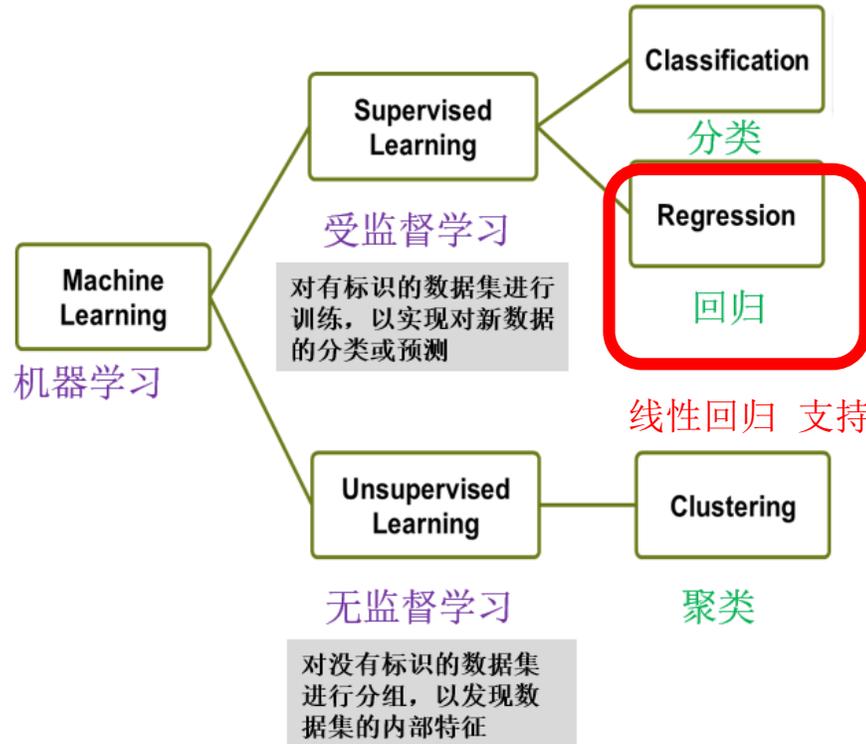
硬件访问

- Data acquisition
- Image capture
- GPU
- Lab instruments

MATLAB机器学习

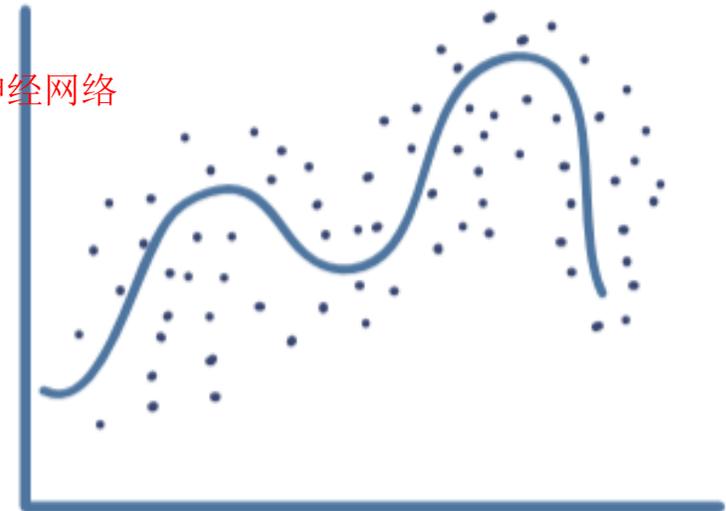


• 回归 (Regression)



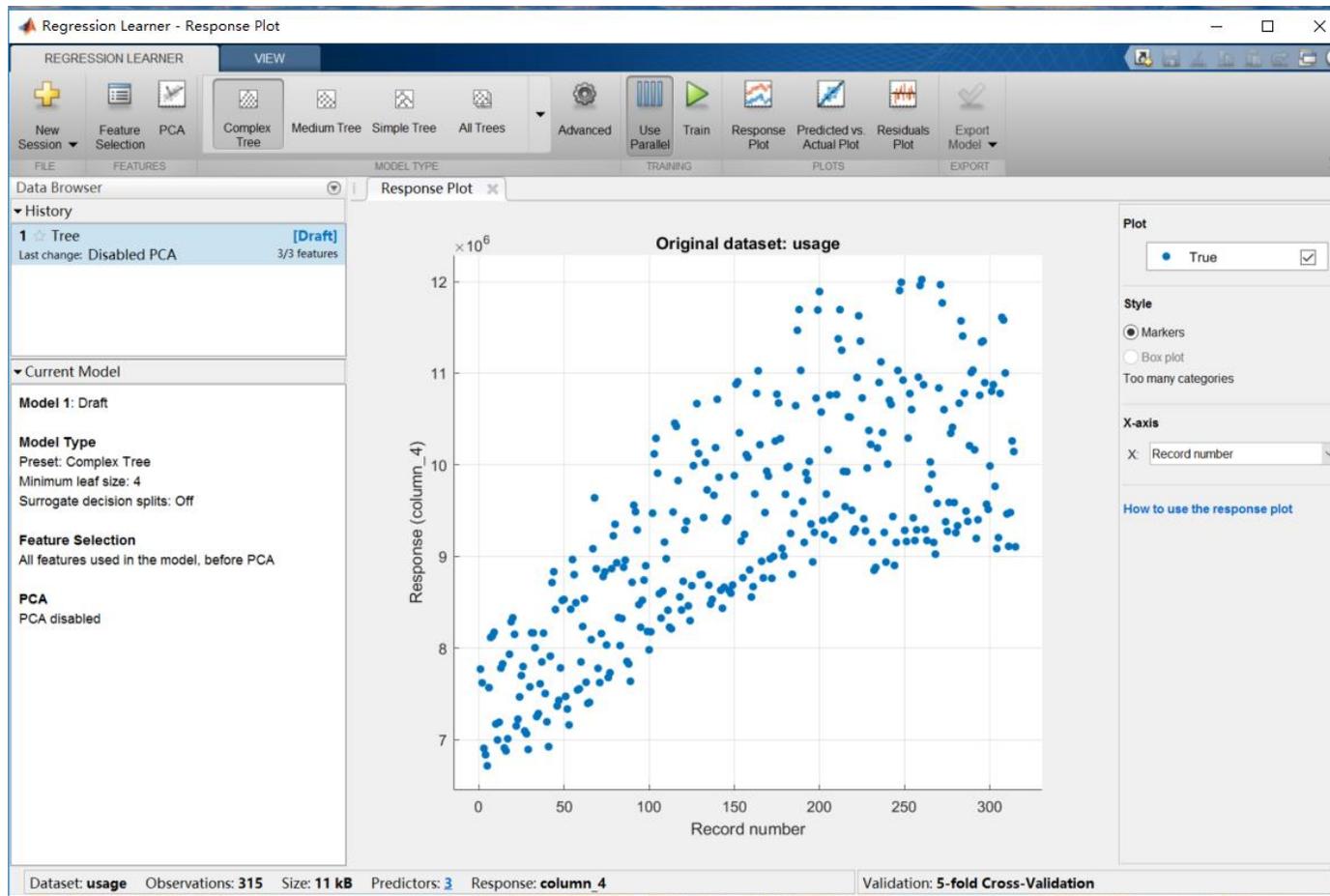
目标:

确定多个变量之间的依赖关系。



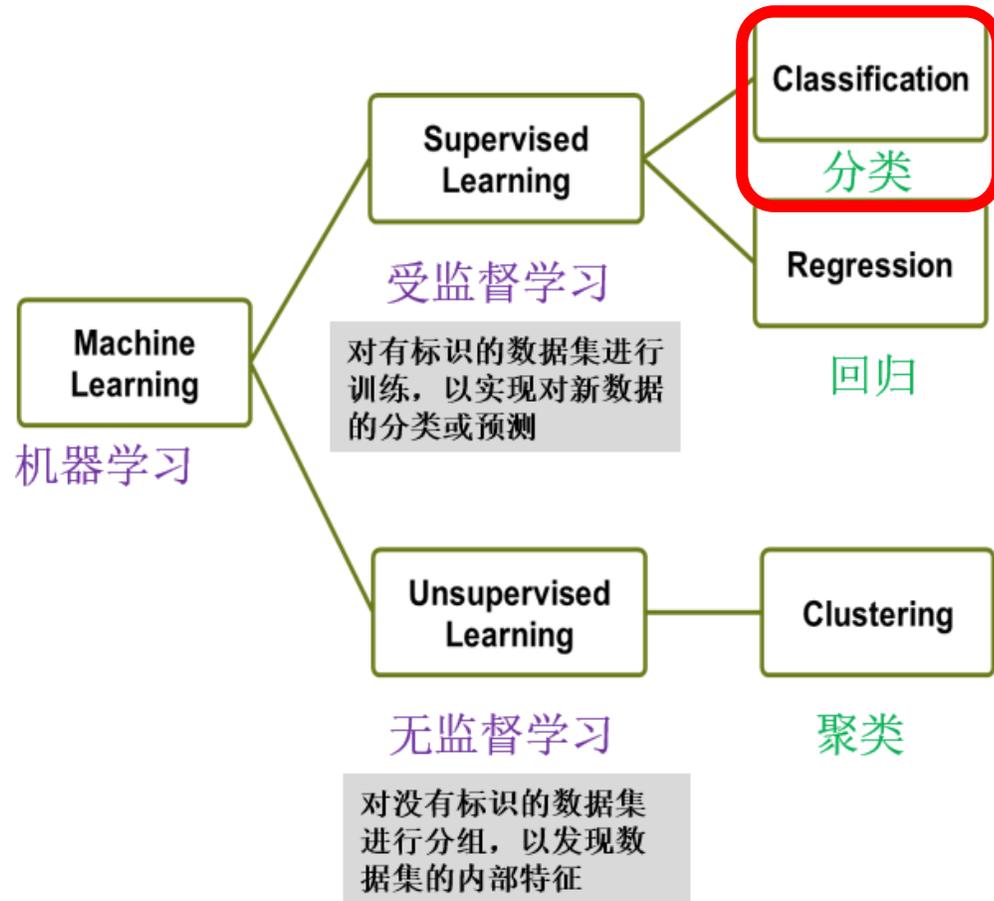
● Regression Learner APP

Regression Learner App是MATLAB 2017a推出的一个新的应用程序（APP）。它囊括了MATLAB所支持的回归分析算法，并以图形化的方式实现特征选取、检查验证、模型训练以及结果评估。其同时支持如下功能：



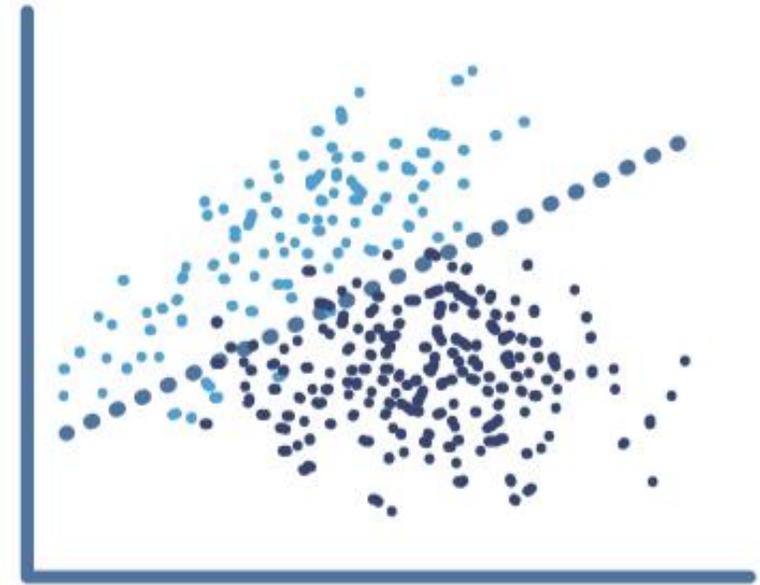
• 分类 (Classification)

支持向量机 判别分析 朴素贝叶斯 最近邻



目标:

利用有标签的数据训练一个分类模型。

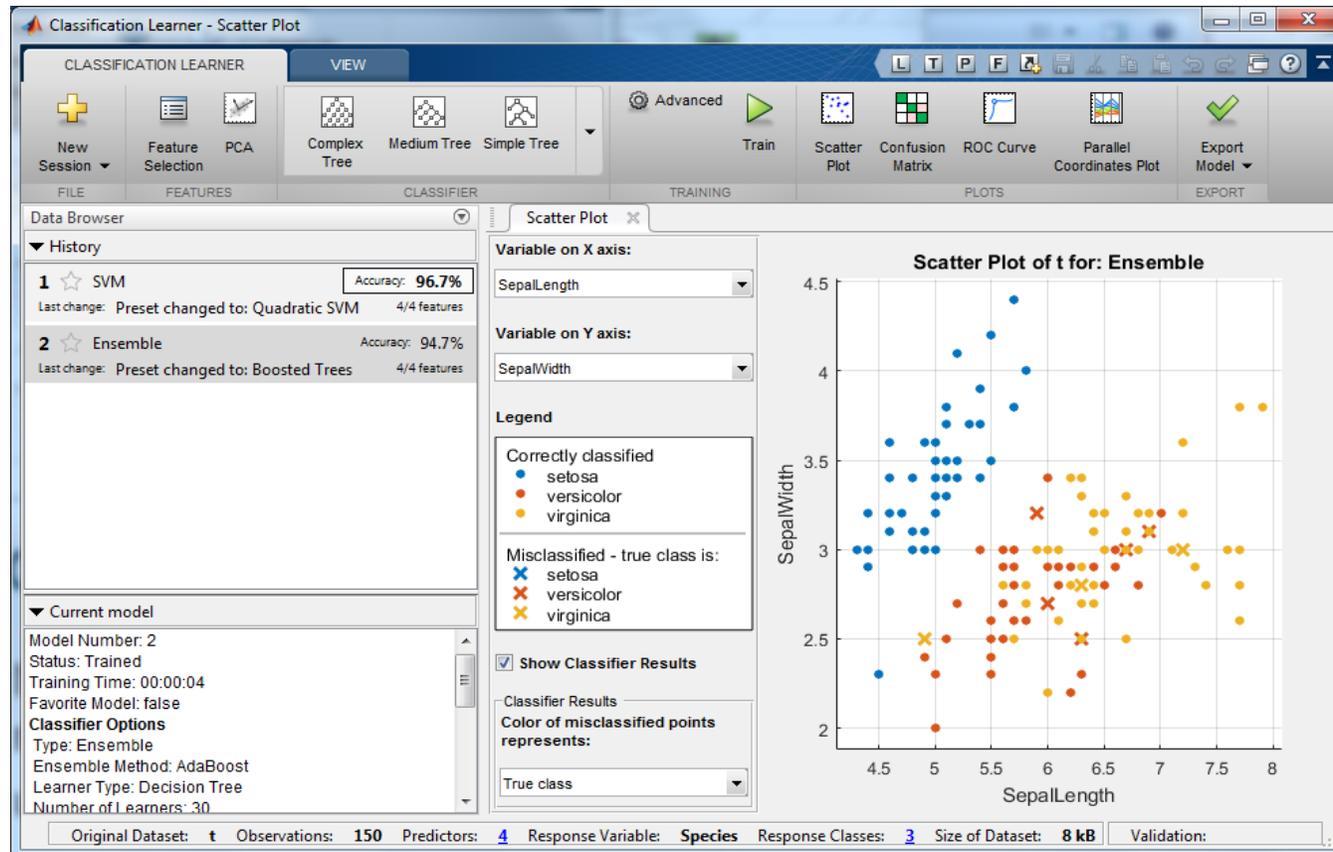


- 分类 (Classification)

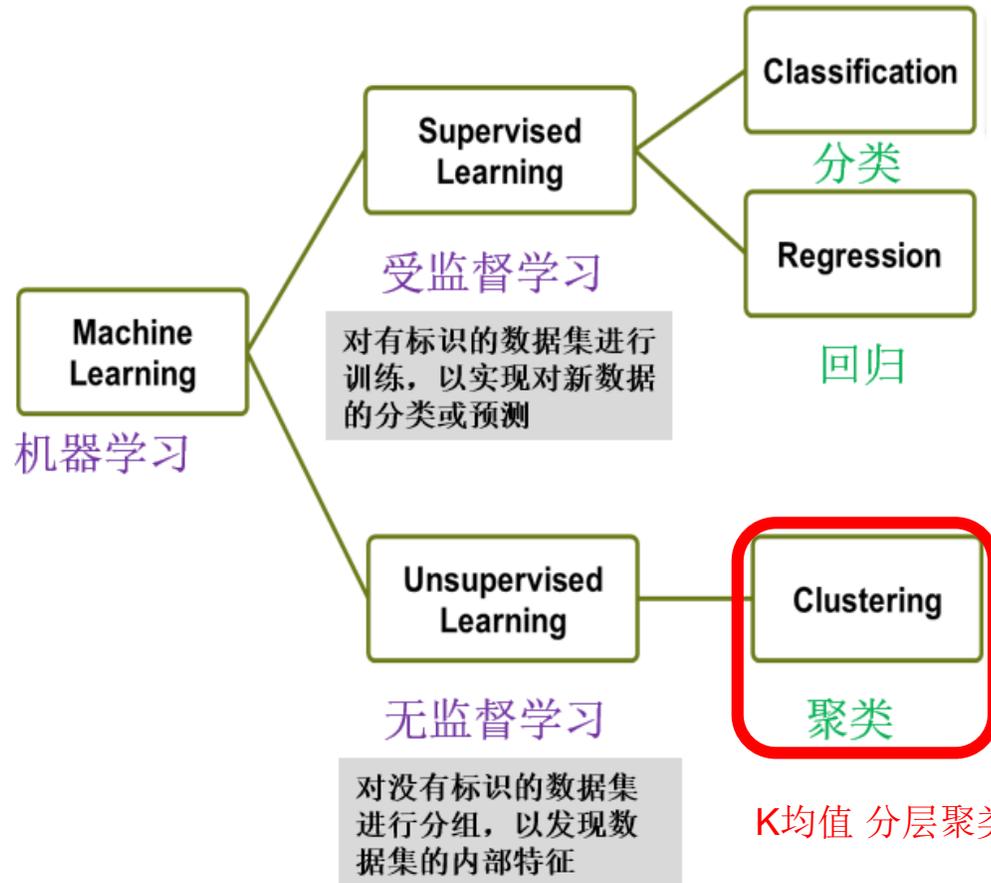


• Classification Learner

Classification Learner app是MATLAB 推出的一个新的应用程序（APP）。它囊括了MATLAB的有监督机器学习算法，并以图形化的方式实现特征选取、检查验证、模型训练以及结果评估。

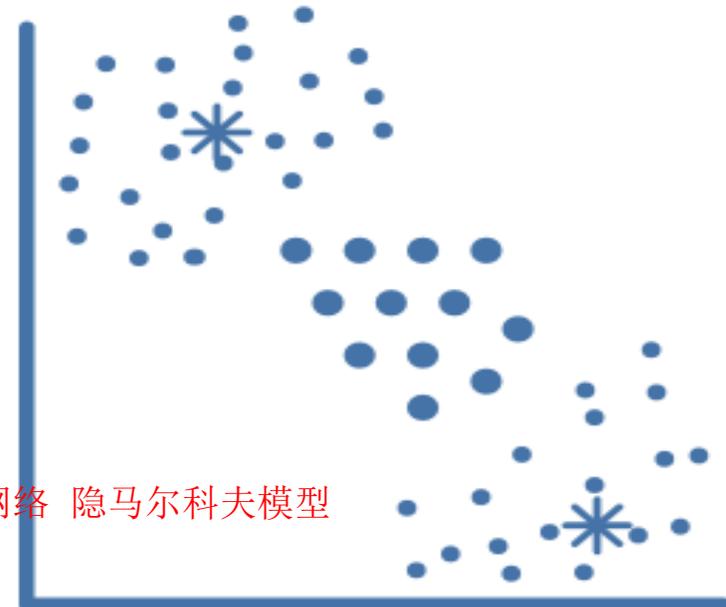


● 聚类 (Clustering)



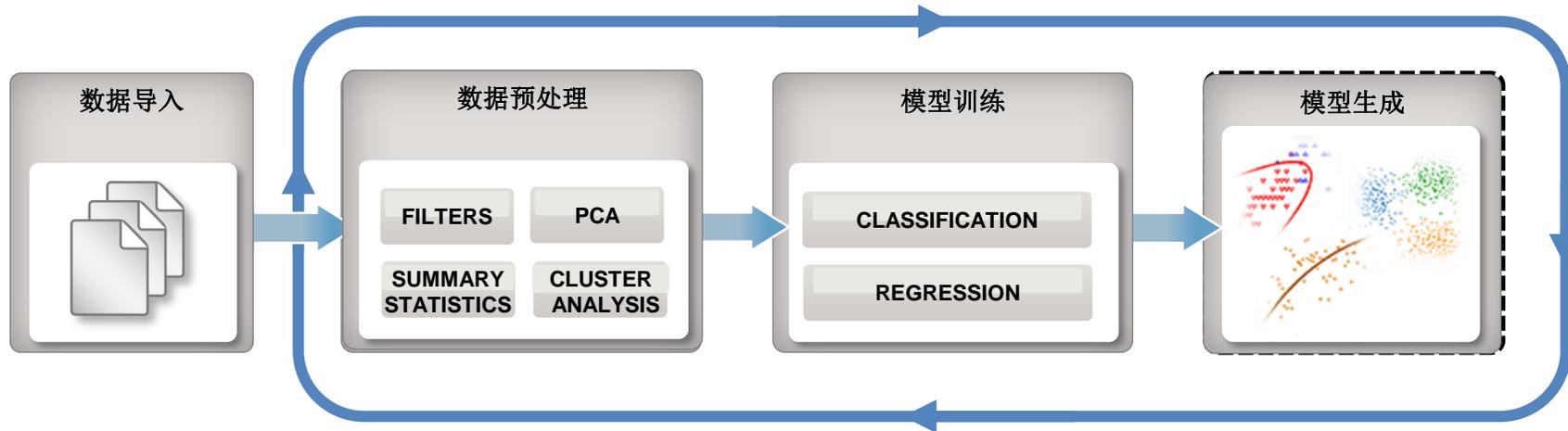
目的:

对未标记数据根据选定的特征进行分组;

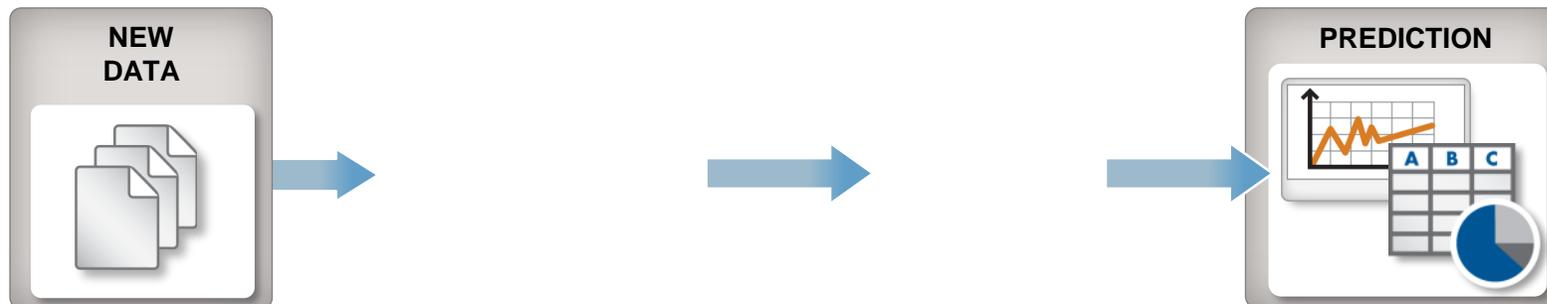


机器学习工作流程

训练: 迭代训练，直到获得满意结果



预测: 将训练模型集成到应用中

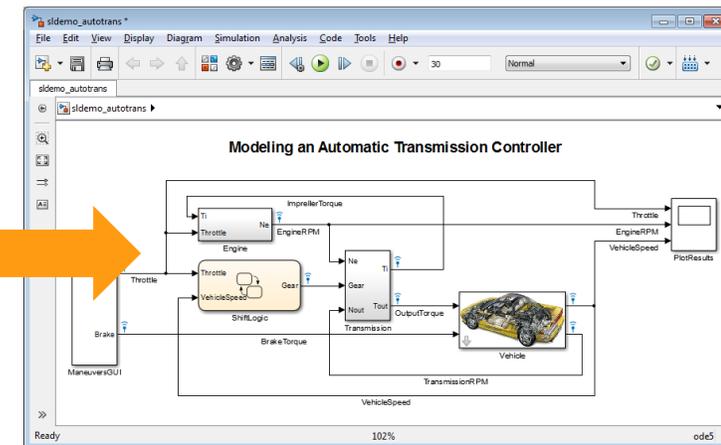
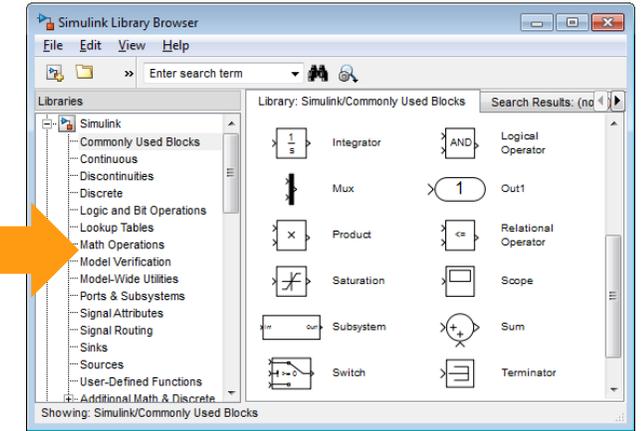
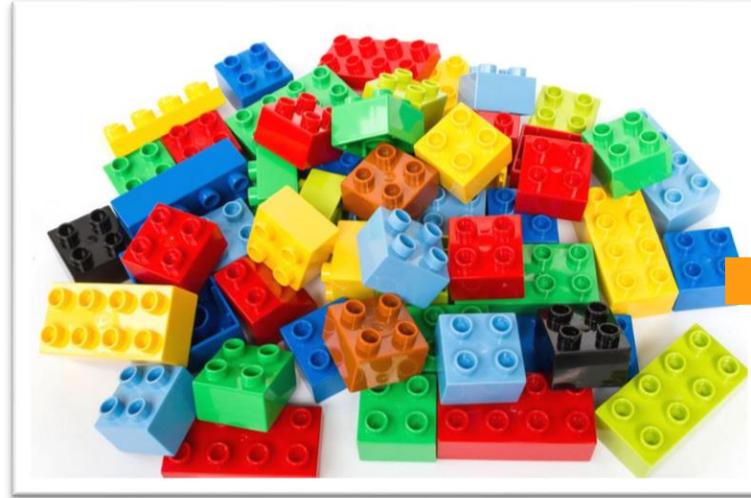
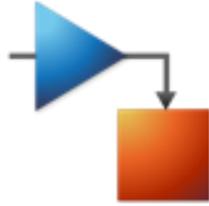


玩转Simulink

- Simulink 建模与仿真快速入门

Simulink 介绍

- 模块化环境
- 行动态系统建模和仿真
- 设计、实现和测试：
 - 控制系统
 - 信号处理系统
 - 通信系统
 - 其他动态系统
- 基于模型设计的平台



Simulink 在各个领域的应用

Eurocopter: Helicopters

Eaton: Hybrid Delivery Truck

Caterpillar: Construction Machine

IAV: CNG/LPG EMS

GM: HVAC

Delphi: Common Rail Diesel

Dongfeng: BMS

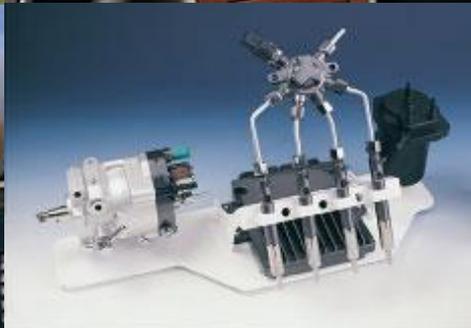
Honeywell: Flight Controls

GM: Hybrid Powertrain

Daimler: Vehicle Controller

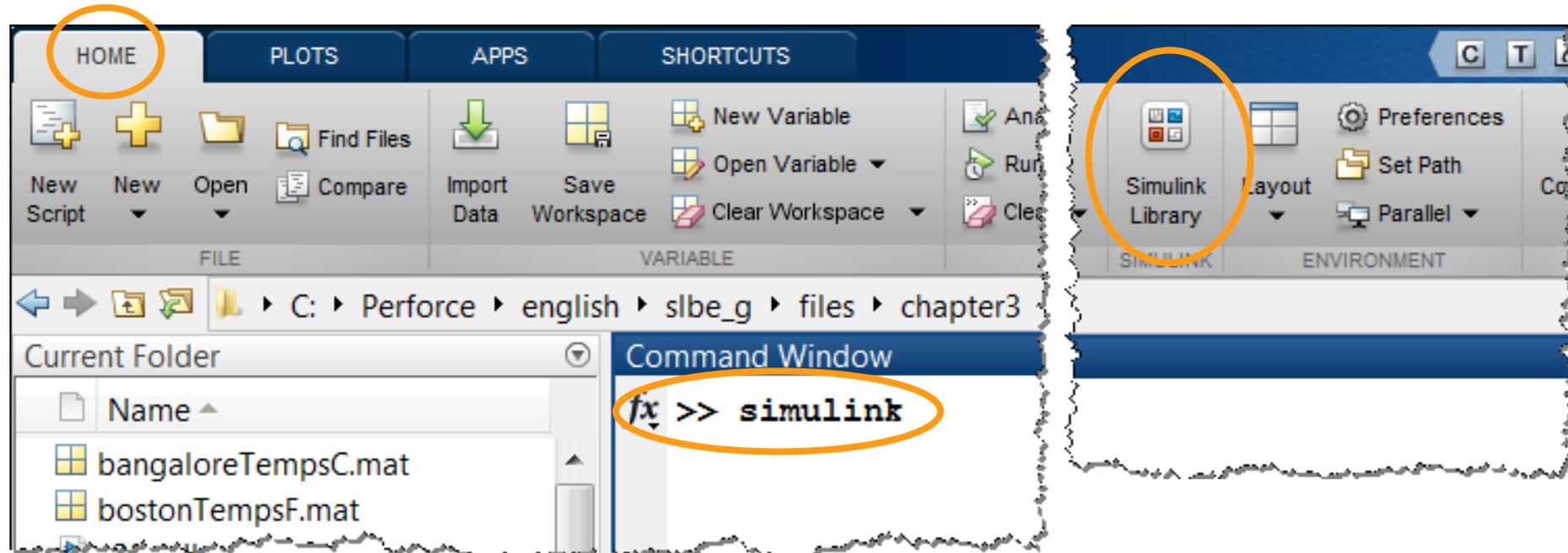
Lear: BCM

Vodafone: Telematics



Simulink 启动

- 在 MATLAB 命令行窗口键入 `simulink` 或者点击 Home 栏 Simulink Library 按钮，可以打开 Simulink 库浏览器



Simulink 库浏览器

工具箱

模块库

模块

模块描述

Simulink Library Browser

Enter search term

DSP System Toolbox/Filtering/Filter Implementations

- Simulink
- Aerospace Blockset
- Communications System Toolbo
- Computer Vision System Toolbo
- Control System Toolbox
- DSP System Toolbox
 - Estimation
 - Filtering
 - Adaptive Filters
 - Filter Designs
 - Filter Implementations
 - Multirate Filters
 - Math Functions
 - Quantizers
 - Signal Management
 - Signal Operations
 - Sinks
 - Sources
 - Statistics
 - Transforms
- Embedded Coder
- Fuzzy Logic Toolbox
- HDL Coder
- HDL Verifier
- Image Acquisition Toolbox
- Instrument Control Toolbox
- Model Predictive Control Toolbo
- Neural Network Toolbox
- OPC Toolbox
- Phased Array System Toolbox
- Real-Time Windows Target
- Report Generator
- Robust Control Toolbox
- SimEvents

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butter

dsparch4/Allpole Filter:

Independently filter each channel of the input over time using an Allpole filter. You can specify filter coefficients using either tunable dialog parameters or separate input ports, which are useful for time-varying coefficients.

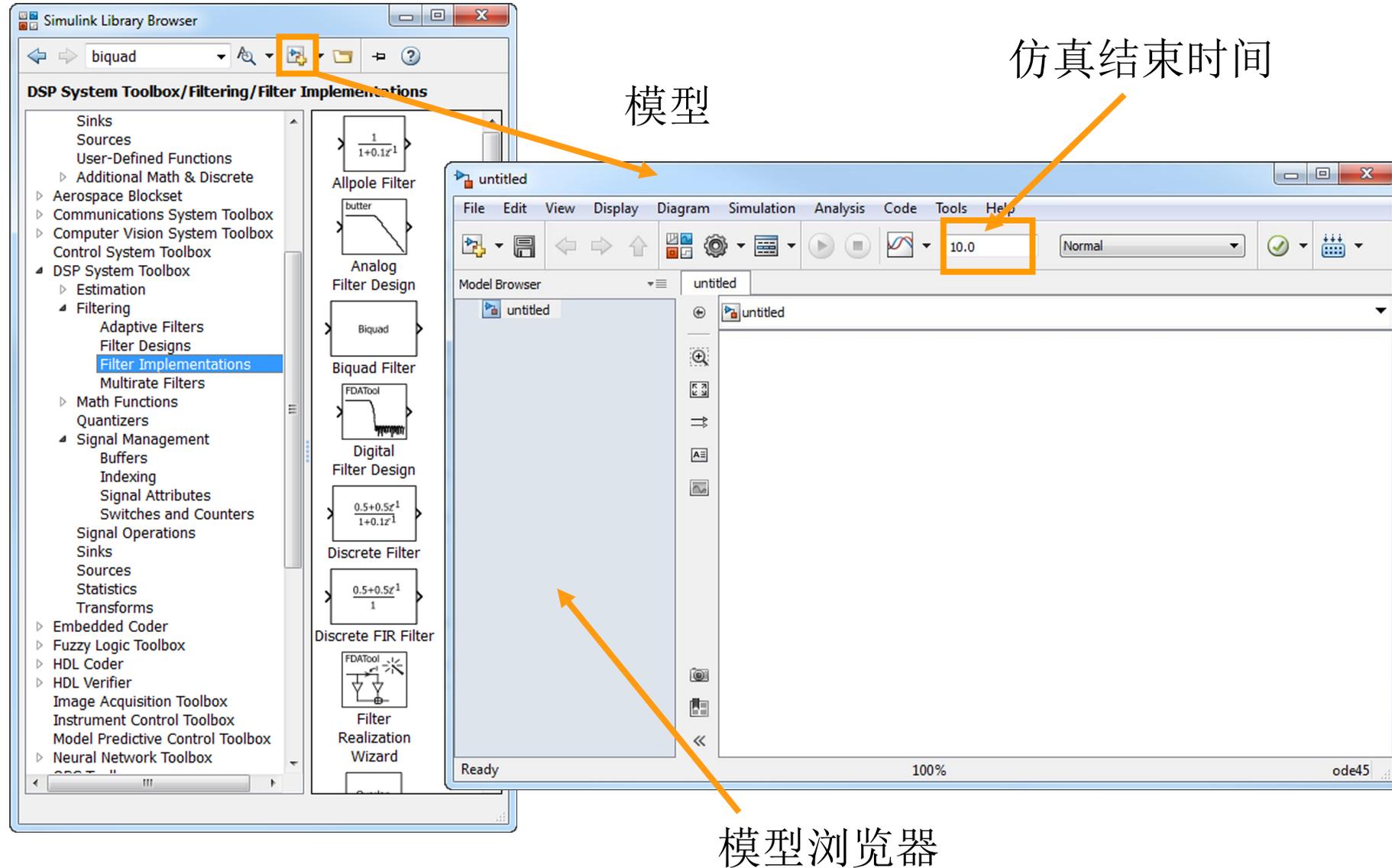
When you use the Direct form or Direct form transposed filter structure, the leading denominator coefficient must be equal to 1.

Filter Realization Wizard

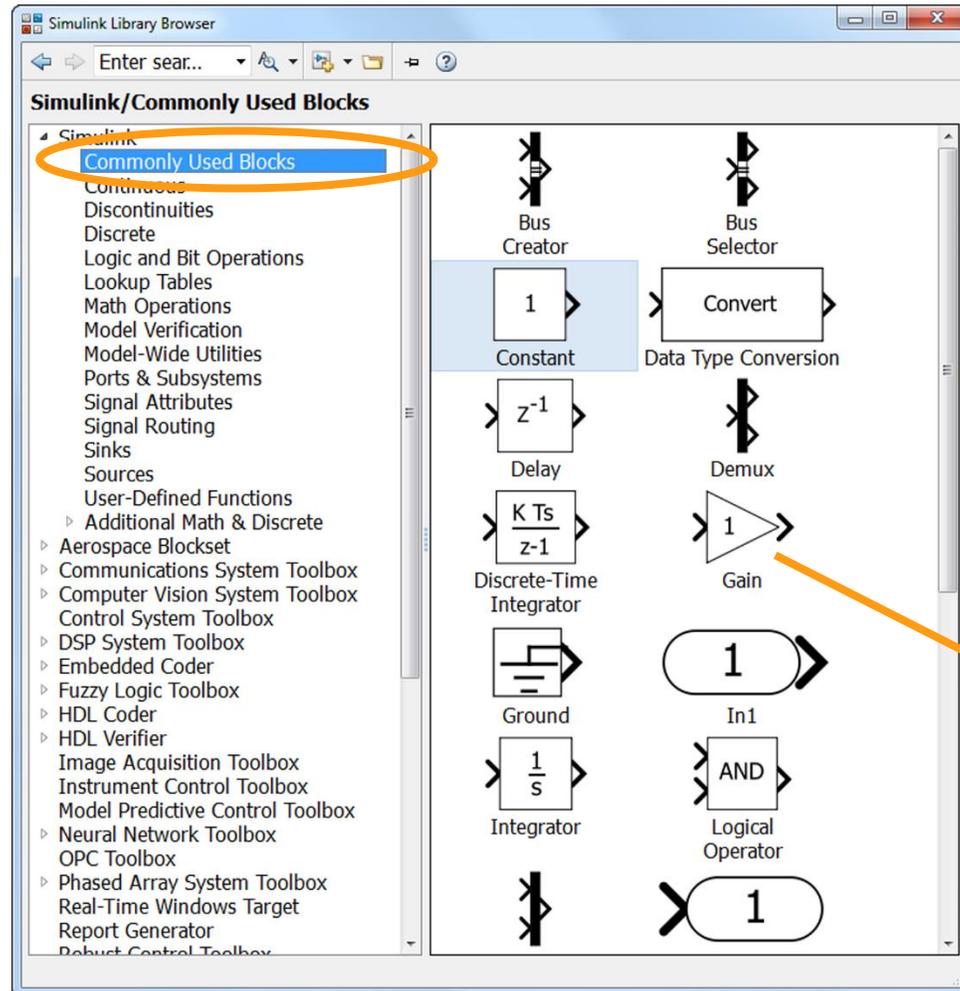
Overlap-Add FFT Filter

Overlap-Save FFT Filter

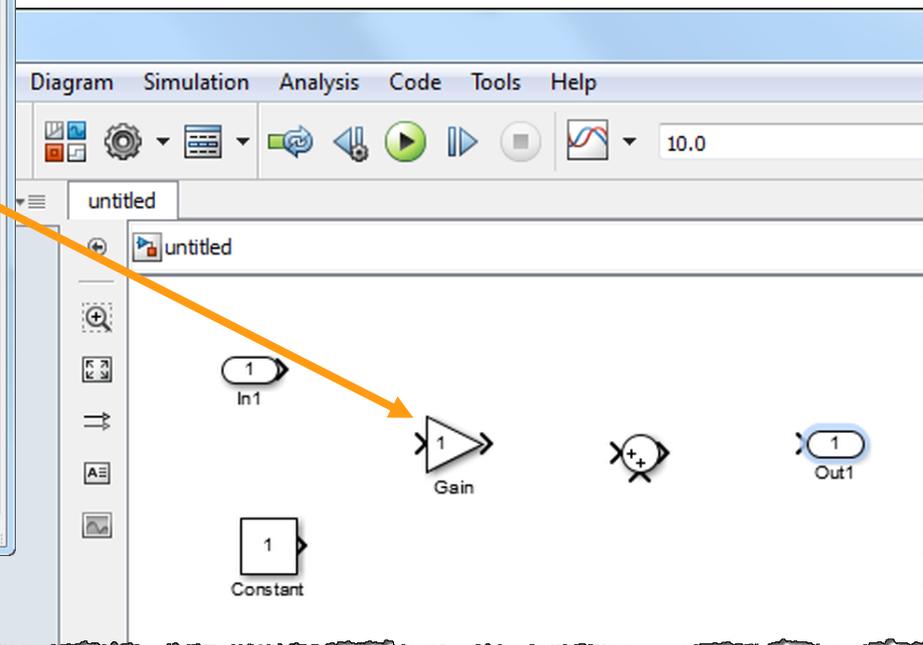
新建模型



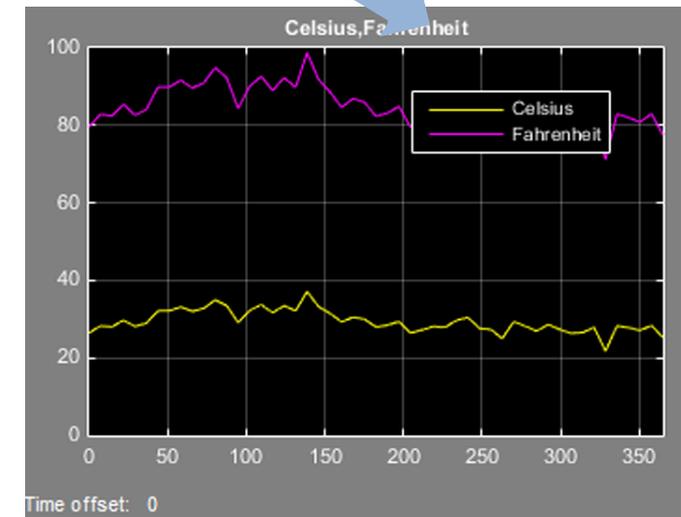
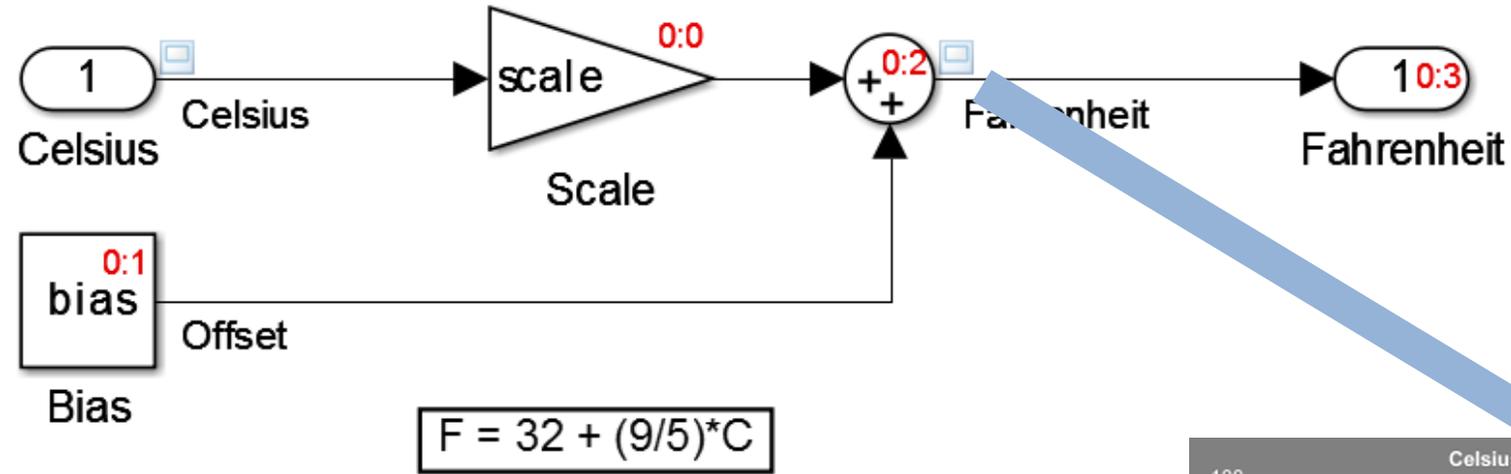
添加模块



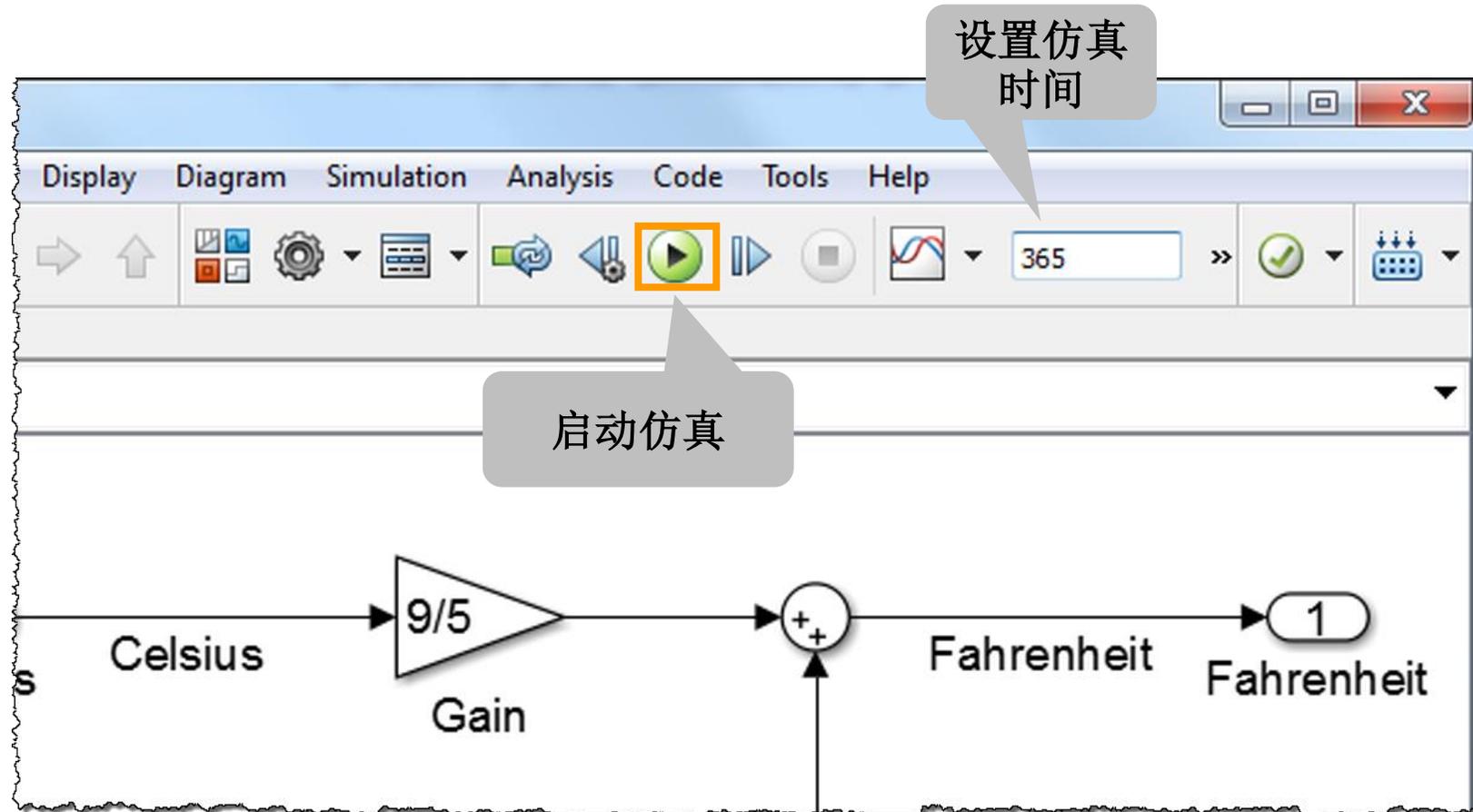
从Simulink 模块库中拖拽一个模块到模型



模块连线



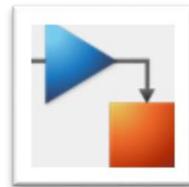
仿真时间



示例1: 从数学公式到模型仿真

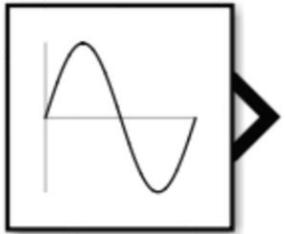
正弦信号的积分

$$A(t) = \int 10\sin(2\pi * 2 * t + 30^\circ) dt - 3$$

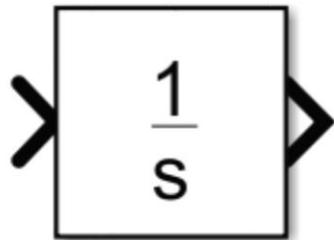


1. 确认所需模块

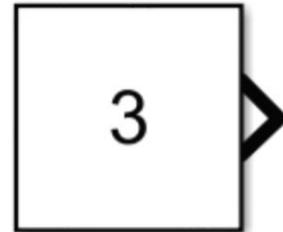
$$A(t) = \int 10\sin(2\pi * 2 * t + 30^\circ)dt - 3$$



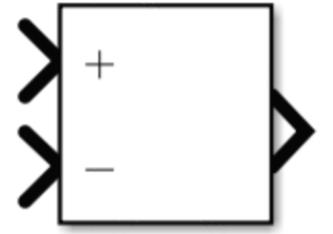
Sine Wave



Integrator



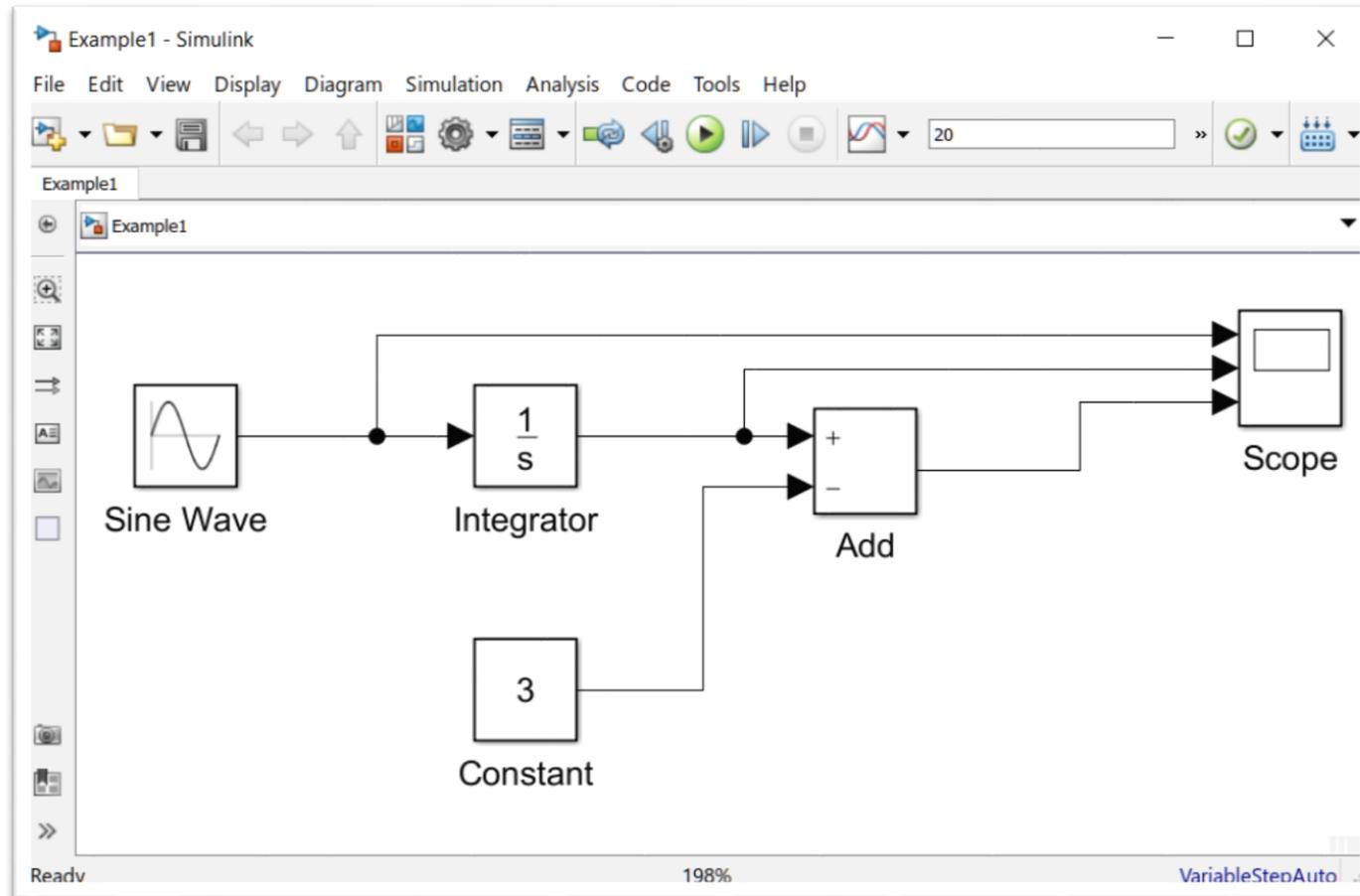
Constant



Add

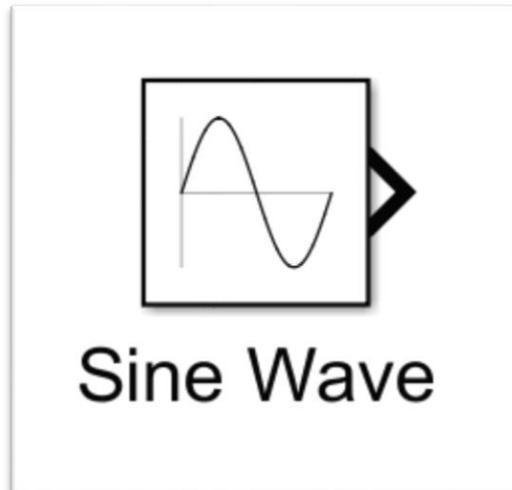
2. 模块连线

$$A(t) = \int 10\sin(2\pi * 2 * t + 30^\circ)dt - 3$$

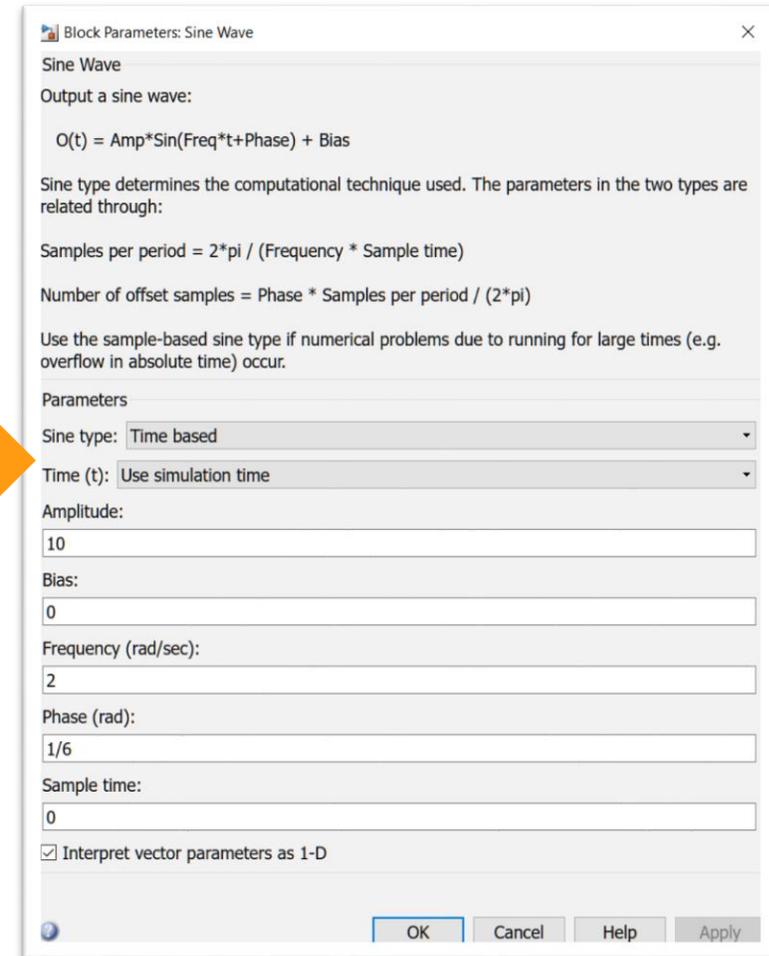


3. 模块参数设置

$$A(t) = \int 10\sin(2\pi * 2 * t + 30^\circ)dt - 3$$

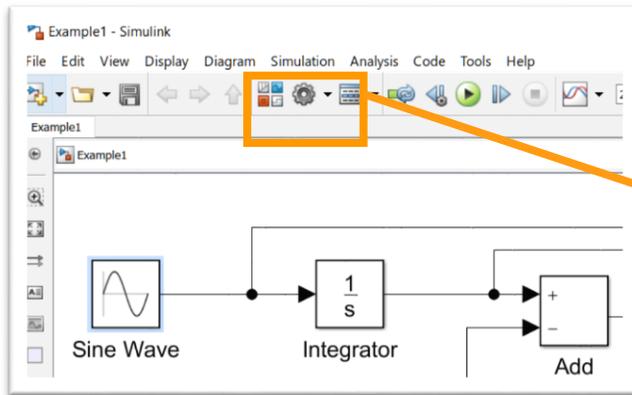


模块参数



4. 模型参数设置

$$A(t) = \int 10\sin(2\pi * 2 * t + 30^\circ)dt - 3$$



模型参数

Configuration Parameters: Example1/Configuration (Active)

★ Commonly Used Parameters All Parameters

Select:

- Solver
- Data Import/Export
- Optimization
- Diagnostics
- Hardware Implementation
- Model Referencing
- Simulation Target
- Code Generation
- Coverage
- HDL Code Generation

Simulation time

Start time: 0.0 Stop time: 20

Solver options

Type: Variable-step Solver: auto (Automatic solver selection)

Additional options

Max step size: 0.1 Relative tolerance: 1e-3

Min step size: auto Absolute tolerance: auto

Initial step size: auto Shape preservation: Disable All

Number of consecutive min steps: 1

Zero-crossing options

Zero-crossing control: Use local settings Algorithm: Nonadaptive

Time tolerance: 10*128*eps Signal threshold: auto

Number of consecutive zero crossings: 1000

Tasking and sample time options

5. 仿真结果演示

$$A(t) = \int 10\sin(2\pi * 2 * t + 30^\circ) dt - 3$$





MATLAB 学习资源

- **www.mathworks.com**
 - Webinars
 - Solutions
 - MATLAB central
- **www.ilovematlab.cn**
 - Answers & Shares
 - Books
- **WeChat & Weibo**

The image shows two overlapping screenshots. The top one is the MATLAB Central website, featuring navigation links like 'File Exchange', 'Answers', 'Newsgroup', 'Link Exchange', and 'Blogs'. It highlights 'Trendy' and 'Cody' sections, and a 'File Exchange' section with recent files such as 'Convert SimBiology(R) model to COBRA Toolbox model' and 'A MATLAB Script for Terrestrial and Celestial Coordinate Conversion'. The bottom screenshot is the Chinese community site 'www.iloveMATLAB.cn', which has a navigation bar with categories like '论坛', '产品', '人物', '硬件支持', '技术专栏', '教师讲义', '书籍', '活动(上海)', '排行榜', and 'MATLAB Central文件交换'. A prominent banner reads 'MATLAB® Central 文件交换 大波MATLAB应用程序和代码分享, 点击获取!' with an arrow pointing to the 'MATLAB Central文件交换' link in the navigation bar. Below the banner is a search bar and a forum section with various topics and a list of forum hotspots.

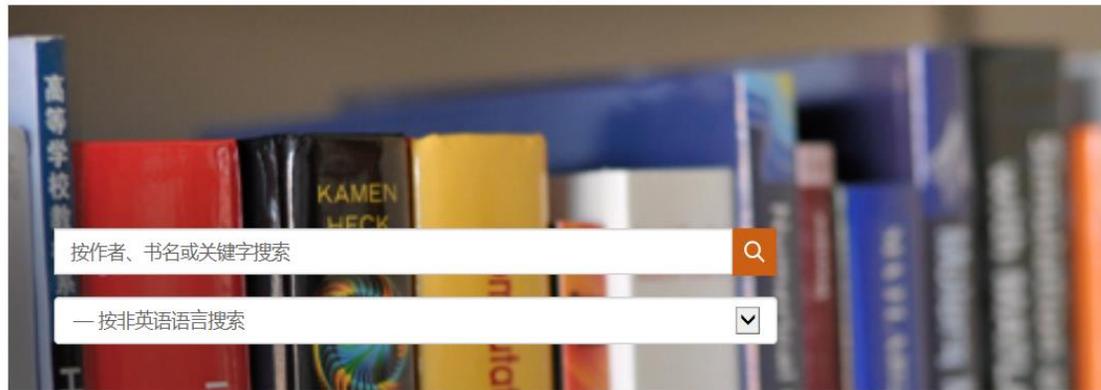
MathWorks 图书项目

<http://cn.mathworks.com/support/books/>

MathWorks® 产品 解决方案 教育 支持 社区 活动

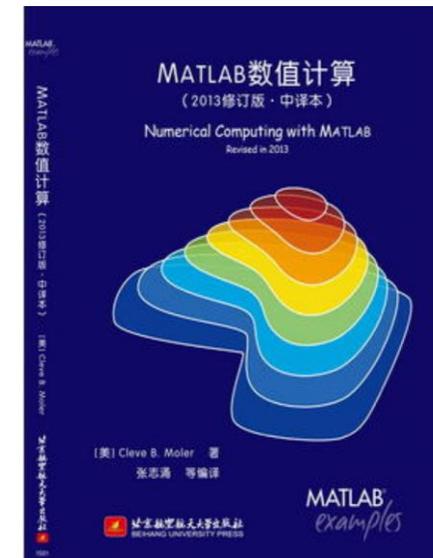
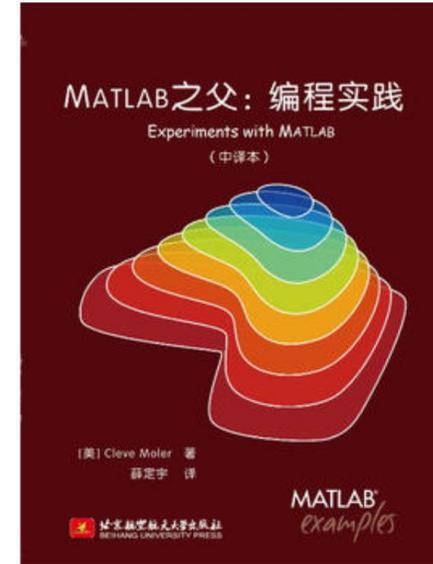
基于 MATLAB 和 Simulink 的书籍

图书主页 | 主题 ▾ | Languages ▾ | 加入图书计划



1500 多本适用于教师、学生和专业人士的书籍

基于 MathWorks 产品的书籍越来越多，反映出这些工具在研发领域的广泛应用。这些书籍的内容涵盖了与使用 MATLAB、Simulink 和其他 MathWorks 产品相关的理论、真实案例和练习。它们为工程、科学、金融和数学学科的教师们提供了课程材料，并可作为学术和工业研究的权威参考资料。



MATLAB官方微信公众号

输入“**中科大**”，获取本次讲座的习题，并提交答案，我们为前三位答题正确的同学寄送精美奖品



MATLAB

谢谢

