MATLAB EXPO 2019

Novedades de las últimas versiones de MATLAB y Simulink

Paz Tárrega y David Pérez
Algorithms in Everything
Using MATLAB & Simulink to Build Algorithms in Everything

Simplifying your work...

...often at higher levels of abstraction.
Using MATLAB & Simulink to Build Algorithms in Everything

Inputs → Design → Outputs

MATLAB & SIMULINK®
Artificial Intelligence

The capability of a machine to match or exceed intelligent human behavior by training a machine to learn the desired behavior.
There are two ways to get a computer to do what you want

Traditional Programming

Data → COMPUTER → Output

Program
There are two ways to get a computer to do what you want

Machine Learning

Data → COMPUTER → Model → Output
Artificial Intelligence

Data → Machine Learning → Deep Learning → Model
Using MATLAB and Simulink to Build Deep Learning Models

Inputs: Data

Design: Machine Learning
  Deep Learning

Outputs: Model
Using Apps for Ground Truth Labeling
Image and Video Data
Using Apps for Ground Truth Labeling
Signal Data
Using Apps for Ground Truth Labeling
Audio Data

Audio Toolbox
Using Apps for Designing Deep Learning Networks
Using Transfer Learning with Pre-trained Models

- AlexNet
- VGG-16
- GoogLeNet
- Inception-v3
- DenseNet-201
- Inception-ResNet-v2
- Xception
- NasNetLarge
- VGG-19
- ResNet-50
- ResNet-101
- ResNet-18
- Places365-GoogLeNet
- MobileNet-v2
- NasNetMobile
- ResNet-50
- Inception-ResNet-v2
- DenseNet-201
- GoogLeNet
- Xception
- NasNetLarge
- SqueezeNet
- MobileNet-v2
- NasNetMobile
- ShuffleNet

Years:
- 2016
- 2017
- 2018
- 2019
Using Models from Other Frameworks

- Keras-Tensorflow
- Caffe
- Caffe2
- Core ML
- MXNet
- Onnx
- PyTorch
- CNTK
- MATLAB

Design

Deep Learning Toolbox

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Deploying Deep Learning Applications

Pre-processing → Post-processing → Coder Products

Deep Learning Application

Intel MKL-DNN Library

NVIDIA TensorRT & cuDNN Libraries

ARM Compute Library
Using MATLAB and Simulink for Reinforcement Learning

Inputs

Data

Machine Learning

Deep Learning

Design

Model

Outputs

MATLAB & Simulink

Reinforcement Learning Toolbox
Using MATLAB and Simulink for Reinforcement Learning
Using MATLAB and Simulink for Reinforcement Learning

Inputs

Data

Machine Learning

Deep Learning

Outputs

Model

Reinforcement Learning Toolbox

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Using MATLAB and Simulink for Reinforcement Learning

Inputs

Generate Data
- Scenario Design
- Simulation-based data generation

Machine Learning
Deep Learning

Design

Model

Outputs

MATLAB & Simulink

Simulink
Reinforcement Learning Toolbox

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Using MATLAB and Simulink for Reinforcement Learning
Using MATLAB & Simulink to Build Algorithms in Everything
Working with Text Data

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Working with Text Data

```matlab
t = readtable(filename,'TextType','string');
disp(t(1:20,6:7))
```

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Working with Text Data

Deep Learning Toolbox
Statistics and Machine Learning Toolbox
Text Analytics Toolbox
MATLAB
Creating Your Own Data
Identifying the Useful Data

Acquire Data → Preprocess Data → Identify Condition Indicators → Train Model → Machine Learning → Deploy & Integrate

- Visualize data
- Extract Features
- Select the most useful features
Identifying the Useful Data
Identifying the Useful Data

Predictive Maintenance Toolbox
Identifying the Useful Data
Designing Decision Logic with Stateflow

```matlab
inNormalRegion = true;
counter = 0;
for i=1:length(inData)
    if(inNormalRegion)
        if(inData(i)<t1)
            counter = counter+1;
            if(counter>=N1)
                inNormalRegion = false;
            end
        else
            counter = 0;
        end
    else
        if(inData(i)>=t2)
            counter = counter+1;
            if(counter>=N2)
                inNormalRegion = true;
            end
        else
            counter = 0;
        end
    end
    if(inNormalRegion)
        outData(i) = inData(i);
    else
        outData(i) = 0;
    end
end
```

- Normal: \[\text{count}(u<t1)\geq N1\]
- Abnormal: \[\text{count}(u\geq t2)\geq N2\]
Using Stateflow in MATLAB

% Callbacks that handle component events
methods (Access = private)
function startupFcn(app)
    app.lanternLogic = Blink.lanternLogic('app',app);
end

function POWERbuttonPushed(app, event)
    app.lanternLogic.powerButton();
end

function COLORbuttonPushed(app, event)
    app.lanternLogic.colorButton();
end

function UIFigureCloseRequest(app, event)
    delete(app.lanternLogic);
    delete(app);
end

function BLINKbuttonPushed(app, event)
    app.lanternLogic.blinkButton();
end
Editing at the Speed of Thought
Editing at the Speed of Thought
Editing at the Speed of Thought
Editing at the Speed of Thought
Editing at the Speed of Thought
Controlling the Execution of Model Components

Schedulable Rate-Based Model

Export Function Model
Controlling the Execution of Model Components
Simplifying Integration with External C/C++ Code

```
#include "rtwdemo_rowlutcol2row_workflow_rowrow.h"

/* Block parameters (default storage) */

PrtP = {
    /* Variable: Tbl_1 */
    /* Referenced by: '<Root>/2-D Lookup Table' */
    {
        1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0,
        15.0, 16.0, 17.0, 18.0, 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0, 26.0, 27.0,
        28.0, 29.0, 30.0, 31.0, 32.0, 33.0, 34.0, 35.0, 36.0, 37.0, 38.0, 39.0, 40.0,
        41.0, 42.0, 43.0, 44.0, 45.0, 46.0, 47.0, 48.0, 49.0, 50.0, 51.0, 52.0, 53.0,
        54.0, 55.0, 56.0, 57.0, 58.0, 59.0, 60.0
    }
};
```
Simplifying Integration with External C/C++ Code
Viewing Generated Code Alongside the Model
Viewing Generated Code Alongside the Model
Estimating Sunrise and Sunset

Using the latitude ($\phi$), the sun's declination ($\delta$) and the solar time correction ($SC$) we can calculate sunrise and sunset times.

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

\[
sunset = 12 + \frac{\cos^{-1}(-\tan \phi \tan \delta)}{15^\circ}
\]

Refer to this page for background and details on the equations used.
Sharing Live Scripts

Exploring Exoplanets

In this example we will explore some data on exoplanets - planets outside our own solar system. The data used here is a subset of data from the NASA Exoplanet Archive. We will start by using the data to answer some questions about the set of exoplanets in the archive. Then we will do some calculations to try to identify planets in the archive that might be capable of supporting life.

```matlab
exoplanets = readtable('exoplanets.xlsx');
exoplanets(strcmp(exoplanets.s_name, 'Alpha'));
```

How Far Away Are these Planets?

There are 90 exoplanets within 50 light-years of earth and 460 exoplanets within 200 light-years.

```matlab
histogram(x%(10^6),exoplanets.st_distance, 'BinWidth', .5)
xline([50 (10^6)]);
ylabel('Number of Planets');
xlabel('Light Years From Earth');
```

Where is the nearest exoplanet?

```matlab
idx = find(exoplanets.st_distance == min(exoplanets.st_distance));
name = char(exoplanets(idx, 's_name'))
```
Sharing Live Scripts

![Live Editor screenshot showing a Live Script with a slider and a dropdown menu.](image_url)

- **P**: 1:40
- **Slider**: 350
- **Drop down**: "carbon dioxide"

**Output**

- **Graph**: "carbon dioxide @ 350 Kelvin"

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Creating Apps

Plate Browser  Summary Tables

Select Files  Current File:  microtiter_data001.csv

Microplate Plot

EC50 Curves

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Previous File  Next File  Clear selection

% Signal

Log [Compound]
Deploying Web Apps
Using MATLAB & Simulink to Build Algorithms in Everything
Evaluating Architectures

Inputs

Architecture

Design

Outputs

MATLAB® & SIMULINK®
Evaluating Architectures

Inputs  Architecture  Design  Outputs

MATLAB & SIMULINK®
Designing System and Software Architectures
Designing System and Software Architectures
Designing **Beyond** System and Software Architectures

Systems and Software

SoC Hardware and Software

AUTOSAR Software

- **System Composer**
- **SoC Blockset**
- **AUTOSAR Blockset**
Using MATLAB & Simulink to Build Algorithms in Everything

Inputs → Architecture → Design → Outputs

Test & Verification → Collaboration → Scaling
Using MATLAB & Simulink to Build Algorithms in Everything
Integrating with Third-party Requirements Tools

**External Requirements**
- .doc
- .xls
- Database

**Simulink Requirements**
- External Requirements
- Authored Requirements

**ReqIF**
- Import
- Edit
- Export

**R2019a**

**Simulink Requirements Tools**
Include Custom Code in Test & Verification

Simulink

Stateflow

C/C++

Simulink Design Verifier

Test & Verification
Using the MATLAB Unit Test Framework

```
>> result.table
ans =
    2×6 table
         Name                 Passed     Failed     Incomplete      Duration       Details
    'test_Predictions/Test_ModelType'   true         false       false       0.12241    [1×1 struct]
    'test_Predictions/Test_Prediction'  false        true         true         0.11542    [1×1 struct]
```
Using the MATLAB App Testing Framework

```matlab
testCase.press(myApp.checkbox)

testCase.choose(myApp.discreteKnob, "Medium")

testCase.drag(myApp.continuousKnob, 10, 90)

testCase.type(myApp.editfield, myTextVar)
```
Using the MATLAB Performance Testing Framework
Using Continuous Integration

Plugins Index

Discover the 1000+ community contributed Jenkins plugins to support building, deploying and automating any project.

Browse categories
- Platforms
- User interface
- Administration
- Source code management

New Plugins
- QRelief
- MATLAB
- MISRA Compliance Report
- Zoom

MATLAB

https://plugins.jenkins.io/
Using Continuous Integration

The Jenkins plugin for MATLAB® enables you to easily run your MATLAB tests and generate test artifacts in formats such as JUnit, TAP, and Cobertura code coverage reports.

Features

- Support to run MATLAB tests, present in the Jenkins workspace automatically. (This also includes the tests present in .prj files)
- Generate tests artifacts in JUnit, TAP & Cobertura code coverage formats.
- Support to run tests, using custom MATLAB command or custom MATLAB script file.
# Using Projects in MATLAB

![MATLAB Project Management Interface](image)

## Project Explorer

<table>
<thead>
<tr>
<th>Name</th>
<th>Status</th>
<th>Git</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
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<td>ACI</td>
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Parallel Simulations in Simulink

Simulation Manager

batchsim

MATLAB Desktop

Simulation Jobs

Simulation Results

Worker

Worker

Worker

Head Worker
Scaling Computations on Clusters and Clouds

MATLAB

Parallel Computing Toolbox

MATLAB Parallel Server

Cloud

GPU

Multi-core CPU
Using MATLAB & Simulink to Build Algorithms in Everything

Inputs → Architecture → Design → Outputs

Test & Verification → Collaboration → Scaling
Specialized Tools for Building Algorithms in Everything

Communications

5G Toolbox

Physical interconnects

SerDes Toolbox

Analog Mixed-Signal

Mixed-Signal Blockset
Developing Autonomous Systems

Perception → Planning → Control
Evaluate Sensor Fusion Architectures
Simulate Path Planning Algorithms
Design Lane-following and Spacing Control Algorithms
Developing Autonomous Systems

Lidar Processing & Tracking

HERE HD Maps & OpenDRIVE Roads

UAV Algorithms

Computer Vision Toolbox

Automated Driving Toolbox

Robotics System Toolbox
Using MATLAB & Simulink to Build Algorithms in Everything

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- Scaling

MATLAB & SIMULINK

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Automotive
Design and simulate AUTOSAR software, interface with HERE HD maps, and generate energy balance reports.

» Learn more

Systems Engineering
Design and analyze system and software architectures with System Composer.

» Learn more

Projects
Use projects in MATLAB and Simulink to organize, manage, and share your work.

» Learn more
Get Started

MATLAB Onramp
Quickly learn the essentials of MATLAB.

Simulink Onramp
Learn to create, edit, and troubleshoot Simulink models.

Deep Learning Onramp
Learn to use deep learning techniques in MATLAB for image recognition.
MATLAB EXPO 2019