# MATLAB EXPO 2018

### MATLAB<sup>®</sup> and Simulink<sup>®</sup> 最新情報 R2018a R2018b

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- Create Your Designs Faster
- Simplify Analysis
- Simulate Faster and Scale Your Work



Live Editor - C:\Demos\ExploreEvents.mlx		
LIVE EDITOR INSERT VIEW		
Image: Compare with the second sec	Section Break	Run Section Run and Advan Run to End SECTION
ExploreEvents.mlx 💥 🕂		
Explore and Analyze Storm Events	ans =	8×18 table
· · · · · ·		Time
Frequency of Events	1	22-Jul-201
Explore the frequency of various storm events and	2	15-Jul-201
locations and the associated damage costs.	3	15-Jul-201
· · ·	4	16-Jul-201
clear	5	15-Jul-201
load prepEvents	6	15-Jul-201
<pre>data = timetable2table(data); hoad(data)</pre>	7	15-Jul-201
incau(uata)	8	15-Jul-201
Visualize with a Heatmap This is helpful in exploring patterns across categories like the events and locations. bigFigure; heatmap(data,'state','weathercats'); xlabel('State') ylabel('Storm Event') title('Frequency of Events by Location')	Availance Costantizzo Densis P Densis P Densis P Densis P Densis P P P P P P P P P P P P P P P P P P P	
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MATLAB

**Live Editor** 

- Use interactive controls to set values in a live script
- Interactively sort table data
- Debug scripts and functions
- Additional subheading styles





#### MATLAB

App Designer

- Date Picker / Tree Component
- Unified property inspector in Design View and Code view
- Code Analyzer
- GUI to App Designer Migration Tool





MATLAB

Simulink

**Stateflow** 





Simulink







**Simulink Onramp** 





Simulink

**Stateflow** 



### **Simplify Analysis with Apps**

#### These interactive applications automate common technical computing tasks

- Signal Analyzer app
  - Visualize, measure, analyze, and compare signals in the time domain, frequency domain, and time-frequency domain
- Econometric Modeler app
  - Perform time series analysis, specification testing, modeling, and diagnostics
- Analog Input Recorder app
  - Acquire and visualize analog input signals
- Wavelet Signal Denoiser app
  - Visualize and denoise time series data

Signal Processing Toolbox Econometrics Toolbox Data Acquisition Toolbox Wavelet Toolbox





### Simplify Analysis by Simulating at Wall Clock Speed

## Slow down the simulation for easier model interactivity

- Especially for models controlled and monitored via Dashboard blocks and other displays
- Useful when model is connected to hardware

🎦 Simulatio	on Pacing	Options: s	ldemo_fue	lsys			×
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(slower)	0.01	0.1	1	10	100	(faster)	
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Help							



#### **Simplify Analysis of Logic**

Debug Stateflow charts with simplified breakpoint management, simulation stepping, and data visualization

- Single menu for setting breakpoints
- Statement-by-statement debugging
- Data values shown in Symbols window





#### **Scale Your Work**

## Use parallel computing to run multiple simulations faster

- Run multiple parallel simulations with parsim
- Monitor simulation status and progress in the Simulation Manager
- Run simulations in the background with batchsim



SIMULATION MANAGER						HH XXXX	XXXX		?
		:							
Stop Job Open Selected	Grid	List	Simulation Details	Show Results					
SIMULATIONS		DISPL	AY	RESULTS					
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Total Simulations			200						
Elapsed Time			00:02:43						
Number of Active Wor	kers		4		Errors/Aborted (0)	Completed (43)	Active (4)	Queued (153)	
Estimated Time Rema	ining		00:02:35						
									1



#### **Scale Your Work**

## Use tall arrays to manipulate and analyze data that is too big to fit in memory

- Use familiar MATLAB functions and syntax
- Built-in support for hundreds of functions
- Customization support for importing, processing, and exporting data
- Works with Spark + Hadoop clusters





#### **Simulate Faster**

## Redesigned execution engine runs MATLAB code faster

- All MATLAB code can now be JIT compiled
- MATLAB runs your code over twice as fast as it did just three years ago
- No need to change a single line of your code
- Increased speed of MATLAB startup in R2018a, R2018b

2.2 2.1 2.0 1.8 1.7 1.7 1.6 1.4 1.2 1.0 1.0 0.8 R2018a R2015a R2017b R2015 R2016a R2016b R2017a

#### Average Speedup in Customer Workflows



#### **Simulate Faster**

#### Accelerate your model using multi-threading and derive frame sizes automatically for multirate signal processing

- New dataflow execution domain available for signal processing applications
- Automatically distribute simulation and code generation across multiple cores
- Automatically calculate signal sizes in frame-based multirate models







- Create Your Designs Faster
- Simplify Analysis
- Simulate Faster and Scale Your Work



#### Platform Productivity



Workflow Depth



Application Breadth



- Deployment of MATLAB Algorithms and Applications
- Code Generation from
   Simulink Models
- Verification and Validation



### **Access Data / Deploy MATLAB Algorithms and Applications**





#### **Access Remote Data**



## Read and write data to and from remote locations using datastore objects.

 Amazon S3 (offered by Amazon Web Services)

 Windows Azure<sup>®</sup> Storage Blob (offered by Microsoft)

Hadoop Distributed File System (HDFS)





### **Deploy MATLAB Web Apps**

## Share App Designer apps on the Web using MATLAB Compiler.

- Package the app for deployment to the MATLAB App Server
- Add the app to the library of MATLAB Web Apps on the server
- Run the app in a browser from any machine with access to the server

						Desktop apps
						Enterprise systems
						Embedded devices
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Desktop apps

### **Deploy MATLAB Algorithms**

Deploy machine learning and deep learning models using automatically generated code

- Generate C code for predictive machine learning and deep learning models
- Generate optimized CUDA code for deep learning, embedded vision, and autonomous systems





### **Connecting Your Design to Hardware**

## Connect directly to hardware with support packages

- Live streaming to and from hardware
- Run Simulink models on low-cost hardware, such as Arduino, Raspberry Pi, and LEGO
- Automatically generate code and run it on microprocessors, FPGAs, and more.





**Raspberry Pi Zero W** 



Raspberry Pi 3 Model B+



LEGO EV3



**Microsemi FPGA** 







assign c[1] = a[2];

endmodule

#### **Deploying to FPGA or ASIC Hardware**







#### **Prepare Model Data for Code Generation**

#### Optimize the data types used in your system under design

- New fxpopt function
- Specify constraints and tolerances to meet your design goals
- Apply data types to your system while minimizing total bit width



AllowableWordLengths: [10 11 12 13 14 15 16 17 18 19 20 21 22 23 24]

Advanced Options

opt =

AdvancedOptions: [1×1 struct]

- Evaluating new solution: cost 246, meets the tolerances.
- Updated best found solution, cost: 246
- Evaluating new solution: cost 245, does not meet the tolerances.
- Evaluating new solution: cost 244, does not meet the tolerances.
- Evaluating new solution: cost 245, meets the tolerances.
- Updated best found solution, cost: 245
- Evaluating new solution: cost 244, meets the tolerances.
- Updated best found solution, cost: 244





#### **Generate Code from Simulink Models**

Access and define all the information in your model related to code generation

- View and define implementation data in one place
- View implementation details without model details
- Improve code performance and ease integration with other C code



Row-major memory layout option and multi-dimensional arrays



#### **Create Tests from Generated Code**

## Generate additional tests to increase coverage of generated code

- Adds on to previously recorded model coverage results
- Covers differences that can exist between generated code and model, such as extra custom code files and shared utility files
- Can execute tests programmatically or within the Test Manager included in Simulink Test



Link to model element



#### Verify models that include C/C++

Analyze and generate tests for Simulink and Stateflow models that use custom code

- Perform design error detection, property proving and test generation for the C/C++ code
- Works with C Caller blocks and Stateflow charts





case 0:

case 1:

break;

break: default:

break;

```
#include "hTimesAbsN.h"
                                                       #include "hfoo.h"
#include "hTimesN.h"
                                                       int foo(int ul) {
double times_abs_n(double val, double n)
                                                           switch(ul) {
    if(val > 0) {
        return times_n(val, n);
    } else {
        return times n(-val, n);
}
                                                           return ul;
```



#### **Closed-Loop PID Autotuning**

Deploy algorithm that performs PID autotuning without opening the feedback loop

- Use Closed-Loop PID Autotuner block to generate autotuning code and deploy to embedded software
- Estimation experiment is performed without opening the feedback loop
- Use to tune PID controller gains for a plant model in Simulink or for a physical plant





#### Platform Productivity



Workflow Depth



Application Breadth



- Deployment of MATLAB Algorithms and Applications
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   Simulink Models
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#### Platform Productivity



Workflow Depth



#### Application Breadth



- Physical Modeling
- Autonomous Systems
- Artificial Intelligence (AI)



### **Model Electronic Systems with Simscape Electrical**

#### Model and simulate electronic, mechatronic, and electrical power systems

- Merge of Simscape Power Systems and Simscape Electronics
- Convert SPICE models to Simscape components
- Generate HDL code from Simscape models for faster simulation on FPGA's



Simscape Electrical HDL Coder



#### **Model Physical Systems**

## Model HVAC control systems and flexible beams

- Model and simulate HVAC systems for a plant, such as a building, automobile, aircraft
- New library contains chambers, reservoirs, local restrictions, energy converters, sources and sensors
- Model flexible beams with symmetrical cross sections
- Note for Simscape in general: Run simulations about 5x faster with local solver option

Primarv Secondary Heat Heat Exchanger Exchanger BЬ Т **General Flexible Beam** Solid General Flevible Res

Inertia

Compressor

711

Turbine



Simscape Simscape Multibody



#### **RF and Antenna Design and Prototyping**

## Use RF and Antenna models through your entire development cycle

- RF top-down design with RF Budget Analyzer app
- Adaptive hybrid beamforming and MIMO system modeling
- RF Power Amplifier modeling and DPD linearization
- RF propagation and 3D terrain visualization
- Design and fabrication of printed (PCB) antennas



RF Toolbox RF Blockset Antenna Toolbox





#### **Design with the Latest Wireless Standards**



5G Toolbox New Product LTE Toolbox WLAN Toolbox Communications Toolbox

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#### **Model-Based Design for Wireless Communications**



- > Algorithm Design and Verification
- > RF, Digital and Antenna Co-Design
- System Verification and Testing
- Rapid Prototyping and Production









Mapping of environments using sensor data

- Segment and register lidar point clouds
- Lidar-Based SLAM: Localize robots and build map environments using lidar sensors







Understanding the environment using computer vision and deep learning techniques

- Object detection and tracking
- Semantic segmentation using deep learning

CamVid Database: Brostow, Gabriel J., Julien Fauqueur, and Roberto Cipolla. "Semantic object classes in video: A high-definition ground truth database." *Pattern Recognition Letters*Vol 30, Issue 2, 2009, pp 88-97.

Deep Learning Toolbox Computer Vision System Toolbox Automated Driving System Toolbox







Decide

& Plan

QO Act

### **Designing Autonomous Systems**

## Design synthetic driving scenarios to test controllers and sensor fusion algorithms

- Design and simulate multisensor tracking and navigation systems
- Interactively design synthetic driving scenarios composed of roads and actors (vehicles, pedestrians, etc.), or use prebuilt Euro NCAP driving scenarios
- Generate visual and radar detections of actors



\$

Perceive

Sense

#### **Driving Scenario Designer App**



## Model predictive control for adaptive cruise control and lane-keeping algorithms

- Use prebuilt blocks instead of starting from scratch
- Simplified application-specific interfaces for configuring model predictive controllers
- Flexibility to customize for your application









📣 MathWorks

### **Full Vehicle Simulation**

Model and simulate vehicle dynamics in a virtual 3D environment





**Ride & handling** 



**Chassis controls** 



**Automated Driving** 

Comes with several prebuilt scenes created with the Unreal<sup>®</sup> gaming engine





#### **Artificial Intelligence**







#### **Predictive Maintenance**









Predictive Maintenance Toolbox New Product



#### **Predictive Maintenance**

## Design and test condition monitoring and predictive maintenance algorithms

- Estimate remaining useful life (RUL)
- Extract features interactively (Diagnostic Feature Explorer app)
   \* available on MATLAB File Exchange
- Import sensor data from local files and cloud storage (Amazon S3, Windows Azure Blob Storage, and Hadoop HDFS)
- Use simulated failure data from Simulink models
- Get started with examples (motors, gearboxes, batteries, and other machines)







#### **Text Analytics**







#### **Text Analytics**



Morphological analysis for Japanese language









#### **Deep Learning**



Output

Deep Learning Toolbox Computer Vision System Toolbox GPU Coder MATLAB Coder











### **Deep Learning is a Major Area of Investment**

1+1(5) Conv 1+1(5)

	~ <i>2016</i>	2017	2018
Access Data	• Image labeling (2014)	<ul> <li>Caffe Model Importer</li> <li>Alexnet</li> <li>VGG-16 / VGG-19</li> <li>Tensorflow-Keras Importer</li> <li>GoogLeNet</li> <li>ResNet-50 / ResNet-101</li> <li>Inception-V3</li> <li>Pixel label (image) datastore</li> <li>Region and pixel labeling</li> <li>Image augmentation</li> </ul>	<ul> <li>SqueezeNet</li> <li>Inception-ResNet-V2</li> <li>ResNet-18</li> <li>ONNX support</li> <li>Mini-batch datastore</li> </ul> Pixel labeling for Video <ul> <li>Audio labeling</li> </ul>
Architectures	<ul> <li>Stacked Autoencoder (2015)</li> <li>CNN classification (2016)</li> <li>Region-based CNN (2016)</li> </ul>	<ul> <li>Fast &amp; Faster R-CNN</li> <li>CNN Regression</li> <li>LSTM Classification</li> <li>DAG Networks</li> </ul>	<ul> <li>LSTM Regression</li> <li>Bidirectional LSTM</li> <li>Deep Network Designer</li> <li>Network Analyzer</li> </ul>





### **Deep Learning is a Major Area of Investment (cont.)**

	~ 2016	2017	2018
Train	<ul> <li>Multi-CPUs and clusters (2012)</li> <li>GPU support (2012)</li> </ul>	<ul> <li>Multi-GPUs and clusters</li> <li>Bayesian optimization for hyper-parameters</li> </ul>	<ul> <li>ADAM &amp; RMSProp</li> <li>Gradient clipping</li> </ul>
Deploy & Share	<ul> <li>C-code generation (2013)</li> <li>Deploy neural network training model (2016)</li> </ul>	Generate CUDA code for NVIDIA <sup>®</sup> GPU	<ul> <li>Deploy deep network onto Intel<sup>®</sup> MKL-DNN, ARM<sup>®</sup> and NVIDIA TensorRT<sup>™</sup></li> <li>DAG ResNet / GoogLeNet / SegNet</li> </ul>





# Network Editor App makes it easier to describe & visualize DAG networks

ImageInputLayer   ImageInputLayer <th></th>	
New Import Duplicate Copy to View Fit to View Zoom Out Arrange Analyze Export   FILe BUILD NAVIGATE LAYOUT ANALYSIS EXPORT   LAYERS Filter layers Filter layers Filter layers Filter layers Filter layers   INPUT ImageInputLayer Inception_5b-r Convolution2D Filter layers Filter layers   SequenceInputLayer Inception_5b-r ReLULayer Filter layer Filter layers   LEARNABLE Inception_5b-r Relulayer Inception_5b-r Relulayer Inception_5b-r Relulayer Inception_5b-r Relulayer	
FILE BUILD NAVIGATE LAYOUT ANALYSIS EXPORT   LAYERS Filter layers inception_5b inception_5b PROPERTIES   INPUT ImageInputLayer Inception_5b-r Convolution2D Inception_5b-r   SequenceInputLayer inception_5b-r inception_5b-r Filter Size 5,5   NumFilters 128   LEARNABLE Integrition Store 1,1	
LAYERS       Filter layers       inception_5b       inception_5b       PROPERTIES         INPUT       ImageInputLayer       Inception_5b-r       Inception_5b-r       Inception_5b-r         SequenceInputLayer       Inception_5b-r       Inception_5b-r       Inception_5b-r       Inception_5b-r         LEARNABLE       Inception_5b-r       Inception_5b-r       Inception_5b-r       Inception_5b-r         IteARNABLE       Inception_5b-r       Inception_5b-r       Inception_5b-r       Inception_5b-r         IteARNABLE       Inception_5b-r       Inception_5b-r       Inception_5b-r       Inception_5b-r	
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TransposedConvolution2D Padding 2,2,2,2	
Weights [5×5×48×128 single]	
FullyConnectedLayer T inception 5b-r Bias [1×1×128 single]	e]
LSTMLayer WeightLearnRateFactor 1	
WeightL2Factor 1	
BiLSTMLayer BiasLearnRateFactor 2	
ACTIVATION BiasL2Factor 0	
ReLULayer	
LeakyReLULayer	
ClippedReLULayer	. I

Model



#### MathWorks

#### Network Analyzer: gives more information about your network





#### **Interoperate With Deep Learning Frameworks**



**ONNX = Open Neural Network Exchange Format** 



#### **Deep Learning**

#### Design, build, and visualize convolutional neural networks

- Access the latest models
- Import pretrained models and use transfer learning
- Automate ground-truth labeling using apps
- Design and build your own models
- Use NVIDIA GPUs to train your models
- Automatically generate high-performance CUDA code for embedded deployment



Deep Learning Toolbox Computer Vision System Toolbox GPU Coder



#### FREE

### Learn to Use MATLAB for Deep Learning in 2 Hours

Launch Deep Learning Onramp







#### What's New in MATLAB and Simulink?

Platform Productivity



- Design Creation
- Analysis
- Simulation, Scaling

Workflow Depth



- Deployment
- Code Generation
- Verification and Validation

Application Breadth



- Physical Modeling
- Autonomous Systems
- Artificial Intelligence (AI)



### **Upgrade your MATLAB Code and Simulink Models**

Web Browser - (3 Errors) Code Compatibility Report (3 Errors) Code Compatibility Report Code Compatibility Report Top 3 Error	- C X H Checks 2 Files	Upgrade Advisor - sf_climate_control File Edit Run Settings Help Fied	- D X
Analysis Date: 05-Sep-2017 14:32:08         MATLAB Version: R2017b         Incompatibility and Syntax Errors <sup>18</sup>	✓ Upgrade Project Report          100%       Passed       Passed         Passed       All Results       Need attention         Show:       All Files       All Results       Need attention         AnalogControl.mdl       analyzeModelFiles.m       Simodels:\AnalogControl.mdl       Stroke Report         AnalogControl.sm       AnalogControl.mdl       Stroke Report         AnalogControl.sk       Check Name       Check Name         f14_airframe_test.m       Check model settings for migration to simplified initii         f14_airframe_test.m       Check model settings for migration to simplified initii         f14_airframe_test.m       Check and update masked blocks in library to use pro         find_top_models.m       Check and update mask to affirm icon drawing comm         sproject_f14.sk       Upgrade_project.m         vertical_channel.sk       wind_gust_lib.sk	Models Libraries MATLAB Code         7       1       8         -       -       -         Image: Passed image	Identify Variant Model blocks and convert those to Vari   Analysis   Upgrade Variant Model blocks to Variant Subsystems contain offers enhanced capabilities while maintaining equivalent fun variant models will be removed in a future release.   Run This Check   Result:   Passed   Identify Variant Model blocks at model level.   Passed   No Variant Model blocks found.
	Check model settings for migration to simplified in Check for model level messages This check finds and reports model level messages for See Also Check model settings for migration to simp Underspecified initialization detection Checks run on 02/01/2018 10:44	nitialization mode Learn more or migrating to simplified initialization mode. plified initialization mode v Publish Report Close	

# MATLAB EXPO 2018