MATLAB EXPO 2018

What’s New in MATLAB and Simulink  R2017b R2018a

Stephan van Beek
Jorik Caljouw
Preceyes Accelerates Development of World’s First Eye-Surgery Robot Using Model-Based Design

Challenge
Develop a real-time control system for robot-assisted surgical procedures performed within the human eye

Solution
Use Model-Based Design with MATLAB and Simulink to model and simulate the control system and use Simulink Coder and Simulink Real-Time to deploy it to a real-time target

Results
- Development Core controller developed by one engineer
- Patient safety assured
- Road map to industrialization set

“MATLAB and Simulink provided a single platform that supported our complete workflow and all the components and protocols we needed for our robotic system. That enabled us to quickly develop a safe, real-time device, ready for clinical investigation.”
- Maarten Beelen, Preceyes

Link to user story
Platform
Productivity

Workflow
Depth

Application
Breadth

Getting your work
done faster

Support for your
entire workflow

Products for the
work you do
▪ Create Your Designs Faster

▪ Simplify Analysis

▪ Simulate Faster and Scale Your Work

▪ Collaborate
Create Your Designs Faster

MATLAB
Live Editor

Explore and Analyze Storm Events

Frequency of Events
Explore the frequency of various storm events and locations and the associated damage costs.

```
clear
load preEvents
data = timetable2table(data);
head(data)
```

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')
```
Create Your Designs Faster

MATLAB

App Designer
Create Your Designs Faster

MATLAB

Simulink
Create Your Designs Faster

MATLAB

Simulink

Stateflow
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
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
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
- Support for hundreds of functions
- 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
Team Collaboration

Use advanced software development features to manage, test, and integrate MATLAB code
Team Collaboration

Use advanced software development features to manage, test, and integrate MATLAB code

MATLAB® Test Report

Overview

- Test Name: uintTest
- Time: 0.1465 seconds

Details

- Test Name: BigTests.BigTestLengthTests
- Time: 0.4516 seconds
- Status: PASSED

Identify differences between model elements, Stateflow charts, and MATLAB Function blocks
Platform Productivity

- Create Your Designs Faster
- Simplify Analysis
- Simulate Faster and Scale Your Work
- Collaborate
- Deployment of MATLAB Algorithms and Applications
- Code Generation from Simulink Models
- Verification and Validation
# Deploy MATLAB Algorithms and Applications

## Access Data
- Sensors
- Files
- Databases

## Analyze Data
- Data exploration
- Preprocessing
- Domain-specific algorithms

## Develop
- AI model
- Algorithm development
- Modeling & simulation

## Deploy
- Desktop apps
- Enterprise systems
- Embedded devices
Deploy MATLAB Algorithms and Applications

Share your work outside of MATLAB without having to recode your algorithms

- Standalone desktop applications
- Add-ins for Microsoft Excel
- Software components to integrate with other languages (C/C++, .NET, Python, Java)
- Software components for web and enterprise applications
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
PID Control Tuning

Implement an embedded PID auto-tuning algorithm

- Automatically tune PID controller gains in real time against a physical plant
- No model of plant dynamics required
- Deploy the auto-tuning algorithm to embedded software using automatic code generation
Prepare Your Model for Code Generation

Prepare model components for code generation
Prepare Your Model for Code Generation

Prepare model components for code generation

Prepare model data for code generation
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
Deploying to FPGA or ASIC Hardware

Algorithm

Algorithm w/ Hardware Implementation

HDL Coder

Fixed-Point HDL

FPGA/ASIC Implementation

HDL Verifier

Native Floating Point

Matrix Support

Vision HDL Toolbox

LTE HDL Toolbox

HDL Checks in Model Advisor
 Verification and Validation

Products for the entire workflow

Simulink Requirements

Simulink Design Verifier

Simulink Check

Simulink Coverage

Simulink Test

Polyspace

Now supports
- Deployment of MATLAB Algorithms and Applications
- Code Generation from Simulink Models
- Verification and Validation
- Autonomous Systems
- Wireless Communications
- Artificial Intelligence (AI)
Designing Autonomous Systems

Perceive

Sense

Decide & Plan

Act
Designing Autonomous Systems

Mapping of environments using sensor data

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

Understanding the environment using computer vision and deep learning techniques

- Object detection and tracking
- Semantic segmentation using deep learning

Designing Autonomous Systems

Design synthetic driving scenarios to test controllers and sensor fusion algorithms

- Interactively design synthetic driving scenarios composed of roads and actors (*vehicles*, *pedestrians*, etc.)
- Generate visual and radar detections of actors
Designing Autonomous Systems

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
Full Vehicle Simulation

Ride & handling

Chassis controls

Automated Driving
Design with the Latest Wireless Standards

- LTE
- 5G
- Wi-Fi 802.11ax
- ZigBee
- NB-IoT
Model-Based Design for Wireless Communications

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

**Design**

- Transmitter
  - Baseband
  - Digital Front End
  - DAC
- Receiver
  - Baseband
  - Digital Front End
  - ADC

**Prototype**

- C Code
- HDL
- SDR Platform

**Implement**

- Processor
- FPGA
- ASIC

**Code Generation and Verification**

- Fixed-Point Designer
- HDL Coder
- HDL Verifier
- LTE HDL Toolbox
- Embedded Coder

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Artificial Intelligence

Data → COMPUTER → Model

Output
Text Analytics

Data

```matlab
repairNotes = 617x1 string array
"PM SERVICE, CHECK TURN SIGNAL, CLUNKING NOISE"
"SERVICEROB,EXT,5604"
"NEED 4 PLOW PINS"
"INSTALL SPINNER ASSY"
"DON'T START"
"DOG BONE PIN BROKEN"
"NEED SERVICE, CHECK BRAKES"
"HYD CAP CHECK ENGINE LIGHT ON"
"TARP VALVE STICKINGRIGHT SIDE MIRROR BRACKET"
"HANDLES IN CAB LOOSE"
"NO PLOW LIGHTS"
```

Model

Output
Text Analytics

Work with text from equipment logs and operator reports

- **Preprocess** raw text data by extracting, filtering, and splitting
- **Visualize** text using word clouds and text scatter plots
- **Develop** predictive models using built-in machine learning algorithms (LDA, LSA, word2vec)
Predictive Maintenance

Data

Sensors

Model

Predictive Maintenance Toolbox

Normal Operation

Monitor Closely

Maintenance Needed

Remaining Useful Life (RUL) Estimation

Failure Threshold

Real Data

Prediction
Predictive Maintenance

Design and test condition monitoring and predictive maintenance algorithms

- 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
- Estimate remaining useful life (RUL)
- Get started with examples (motors, gearboxes, batteries, and other machines)
Deep Learning

Data

Model

Output

Neural Network Toolbox
Computer Vision System Toolbox
GPU Coder

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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

Neural Network Toolbox
Computer Vision System Toolbox
GPU Coder

![Prediction (TitanXP GPU)](chart)

- TensorFlow
- MATLAB
- MXNet
- GPU Coder

Images / sec

- AlexNet
- ResNet-50
- VGG-16

Images / sec
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
- Collaboration

Workflow Depth
- Deployment
- Code Generation
- Verification and Validation

Application Breadth
- Autonomous Systems
- Wireless Communications
- Artificial Intelligence (AI)

MATLAB EXPO 2018
Upgrade your MATLAB Code and Simulink Models