What’s New in MATLAB 2015

Joe Hicklin

MATLAB EXPO 2015
UNITED KINGDOM
Talks showing off new features

- What’s New in Simulink in Releases 2015a and 2015b
  - 11:15–11:45

- Machine Learning for Predictive Modelling
  - 14:30 – 15:15

- Development and Testing of Robotic Applications Using MATLAB and Simulink
  - 16:15 – 17:00
A quick look at some new features

MATLAB Compiler
C/C++
Java
.NET
Python

MATLAB Workspace Preferences
MATLAB array size limit
- Limit the maximum array size to a percentage of RAM
  - 1%
  - 50%
  - 100%

Slower in R2015b
Faster in R2015b

MATLAB EXPO 2015
UNITED KINGDOM
New Axis Location: origin

\[ x = -10:0.01:10; \]
\[ \text{plot}(x, \text{sinc}(x)) \]
New Axis Location: origin

\[ x = -10:0.01:10; \]
\[ \text{plot}(x, \text{sinc}(x)) \]

```
set (gca, 'xaxislocation', 'origin')
```
New Axis Location: origin

\[ x = -10:0.01:10; \]

\[ \text{plot}(x, \text{sinc}(x)) \]

\[ \text{set}(\ gca, \ 'xaxislocation', \ 'origin' \ ) \]

\[ \text{set}(\ gca, \ 'yaxislocation', \ 'origin' \ ) \]
Bivariate Histograms

\[ x = \text{randn}(100000, 1); \]

\text{histogram}(x)
Bivariate Histograms

\[
x = \text{randn}(100000, 1);
\]

\[
y = x \times \text{randn}(100000, 1);
\]

\[
\text{histogram2}(x, y)
\]
Array Size Limit

Have you done this?

% I need an array with a million elements
Array Size Limit

Have you done this?

% I need an array with a million elements
V = rand(1000000);
Array Size Limit

Have you done this?
% I need an array with a million elements
V = rand(1000000);

What happens now?
Array Size Limit

Have you done this?

% I need an array with a million elements
V = rand(1000000);

What happens now?

Error using rand
Requested 1000000x1000000 (7450.6GB) array exceeds maximum array size preference.
Array Size Limit

Error using rand
Requested 1000000x1000000 (7450.6GB) array exceeds maximum array size preference.
Working with “Grouped Data”

What is the average departure delay for each airline?

```
>> T(1:15,:)          
ans =
```

<table>
<thead>
<tr>
<th>DepTime</th>
<th>ArrTime</th>
<th>UniqueCarrier</th>
<th>FlightNum</th>
<th>ArrDelay</th>
<th>DepDelay</th>
<th>Origin</th>
<th>Dest</th>
</tr>
</thead>
<tbody>
<tr>
<td>'1434'</td>
<td>'1522'</td>
<td>'AS'</td>
<td>67</td>
<td>7</td>
<td>14</td>
<td>'SEA'</td>
<td>'KTN'</td>
</tr>
<tr>
<td>'1545'</td>
<td>'1628'</td>
<td>'AS'</td>
<td>67</td>
<td>-7</td>
<td>-5</td>
<td>'KTN'</td>
<td>'SIT'</td>
</tr>
<tr>
<td>'1500'</td>
<td>'1600'</td>
<td>'AS'</td>
<td>67</td>
<td>25</td>
<td>20</td>
<td>'SEA'</td>
<td>'KTN'</td>
</tr>
<tr>
<td>'1114'</td>
<td>'1342'</td>
<td>'TX'</td>
<td>469</td>
<td>2</td>
<td>-1</td>
<td>'SJU'</td>
<td>'MIA'</td>
</tr>
<tr>
<td>'1725'</td>
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<td>'ER'</td>
<td>240</td>
<td>-2</td>
<td>0</td>
<td>'SJU'</td>
<td>'PHL'</td>
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<tr>
<td>'700'</td>
<td>'1101'</td>
<td>'AR'</td>
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<td>'MIA'</td>
</tr>
<tr>
<td>'1301'</td>
<td>'1925'</td>
<td>'AR'</td>
<td>606</td>
<td>-6</td>
<td>1</td>
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<td>'SJU'</td>
</tr>
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<td>'1326'</td>
<td>'1947'</td>
<td>'AR'</td>
<td>919</td>
<td>1</td>
<td>7</td>
<td>'ORD'</td>
<td>'SJU'</td>
</tr>
<tr>
<td>'945'</td>
<td>'1249'</td>
<td>'AS'</td>
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<td>64</td>
<td>65</td>
<td>'KTN'</td>
<td>'SEA'</td>
</tr>
<tr>
<td>'700'</td>
<td>'752'</td>
<td>'AS'</td>
<td>60</td>
<td>2</td>
<td>0</td>
<td>'JNU'</td>
<td>'KTN'</td>
</tr>
<tr>
<td>'825'</td>
<td>'1100'</td>
<td>'AS'</td>
<td>60</td>
<td>-10</td>
<td>0</td>
<td>'KTN'</td>
<td>'SEA'</td>
</tr>
<tr>
<td>'740'</td>
<td>'1034'</td>
<td>'AS'</td>
<td>60</td>
<td>14</td>
<td>0</td>
<td>'KTN'</td>
<td>'SPA'</td>
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<tr>
<td>'1002'</td>
<td>'1025'</td>
<td>'US'</td>
<td>295</td>
<td>-9</td>
<td>-3</td>
<td>'DCA'</td>
<td>'IND'</td>
</tr>
</tbody>
</table>
Working with “Grouped Data”

```matlab
[groups, airline] = findgroups(T.UniqueCarrier);
```

<table>
<thead>
<tr>
<th>groups(1:10)</th>
<th>airline</th>
</tr>
</thead>
<tbody>
<tr>
<td>ans =</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>'AA'</td>
</tr>
<tr>
<td>4</td>
<td>'AS'</td>
</tr>
<tr>
<td>4</td>
<td>'B6'</td>
</tr>
<tr>
<td>4</td>
<td>'CO'</td>
</tr>
<tr>
<td>23</td>
<td>'DH'</td>
</tr>
<tr>
<td>9</td>
<td>'DL'</td>
</tr>
<tr>
<td>2</td>
<td>'EA'</td>
</tr>
<tr>
<td>2</td>
<td>'EV'</td>
</tr>
<tr>
<td>2</td>
<td>'F9'</td>
</tr>
<tr>
<td>2</td>
<td>'FL'</td>
</tr>
<tr>
<td>2</td>
<td>'HA'</td>
</tr>
<tr>
<td>2</td>
<td>'HP'</td>
</tr>
<tr>
<td>2</td>
<td>'HI'</td>
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<td>2</td>
<td>'MO'</td>
</tr>
<tr>
<td>2</td>
<td>'NK'</td>
</tr>
<tr>
<td>2</td>
<td>'OH'</td>
</tr>
<tr>
<td>2</td>
<td>'OO'</td>
</tr>
<tr>
<td>2</td>
<td>'PA'</td>
</tr>
<tr>
<td>2</td>
<td>'PI'</td>
</tr>
<tr>
<td>2</td>
<td>'PS'</td>
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<td>2</td>
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</tr>
<tr>
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<td>'UA'</td>
</tr>
<tr>
<td>2</td>
<td>'US'</td>
</tr>
<tr>
<td>2</td>
<td>'WN'</td>
</tr>
<tr>
<td>2</td>
<td>'XE'</td>
</tr>
<tr>
<td>2</td>
<td>'TV'</td>
</tr>
<tr>
<td>ans =</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>'AS'</td>
</tr>
<tr>
<td>9</td>
<td>'AS'</td>
</tr>
<tr>
<td>2</td>
<td>'AS'</td>
</tr>
<tr>
<td>2</td>
<td>'TK'</td>
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<tr>
<td>9</td>
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<tr>
<td>2</td>
<td>'AA'</td>
</tr>
<tr>
<td>2</td>
<td>'AA'</td>
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<tr>
<td>2</td>
<td>'EA'</td>
</tr>
<tr>
<td>2</td>
<td>'AA'</td>
</tr>
<tr>
<td>2</td>
<td>'EA'</td>
</tr>
<tr>
<td>T.UniqueCarrier(1:10)</td>
<td>ans =</td>
</tr>
<tr>
<td>'AS'</td>
<td></td>
</tr>
<tr>
<td>'AS'</td>
<td></td>
</tr>
<tr>
<td>'AS'</td>
<td></td>
</tr>
<tr>
<td>'TK'</td>
<td></td>
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<td>'EA'</td>
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<tr>
<td>'AA'</td>
<td></td>
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<tr>
<td>'AA'</td>
<td></td>
</tr>
<tr>
<td>'EA'</td>
<td></td>
</tr>
<tr>
<td>'AA'</td>
<td></td>
</tr>
<tr>
<td>'EA'</td>
<td></td>
</tr>
</tbody>
</table>
Working with “Grouped Data”

\[
\text{meanDelay} = \text{splitapply}( \text{mean}, \text{T.DepDelay}, \text{groups} );
\]

\[
\begin{array}{ccc}
8.4664 & \text{ans} = 14 \quad 14 \\
7.8672 & -5 \quad 4 \\
0.7273 & 20 \quad 4 \\
7.8045 & -1 \quad 23 \\
10.9007 & 0 \quad 9 \\
7.6078 & 0 \quad 2 \\
9.9009 & 0 \quad 2 \\
7.2765 & 1 \quad 9 \\
9.7174 & 7 \quad 2 \\
12.3190 & \text{ans} = 2 \\
8.8806 & \\
10.0412 & \\
-1.1978 & \\
7.6999 & \\
2.6522 & \\
9.2473 & \\
5.7511 & \\
9.3809 & \\
7.1375 & \\
5.6855 & \\
9.3467 & \\
7.0602 & \\
7.7787 & \\
3.9444 & \\
9.2057 & \\
7.6384 & \\
8.9213 & \\
8.8746 & \\
13.5595 & \\
\end{array}
\]
Working with “Grouped Data”

```matlab
[groups, airline] = findgroups(T.UniqueCarrier);
meanDelay = splitapply(@mean, T.DepDelay, groups);
```

```matlab
table(airline, meanDelay)
```
We support many types of hardware
And now there are two more

We have added support for two popular new systems:

Raspberry Pi 2
- 900 MHz
- Quad core
- 1 GB ram
And now there are two more

We have added support for two popular new systems:

BeagleBone Black
- 1 GHz
- 512 MB ram
- 4GB flash rom
- 3D Graphics
Python Integration

- MATLAB integrates with several programming languages:
  - C/C++
  - Java
  - FORTRAN
  - COM
  - .NET
  - Python
Call Python from MATLAB

MATLAB Interface to Python

```matlab
>> s = py.string.Template( ...
    'Patient Name: $who')

>> substitute(s,pyargs('who','Smith'))

Patient Name: Smith
```
Call MATLAB from Python

MATLAB Engine API

```python
>>> import matlab.engine
>>> eng = matlab.engine.start_matlab()
>>> eng.sqrt(9.0)
3.0
```
Deploy MATLAB Components for Python

- MATLAB Compiler SDK
  - Creates deployable MATLAB components for integration with applications written in Python
Graphs in MATLAB

A directed graph with four nodes and three edges.
Graphs in MATLAB

A Graph object
Create
Manipulate
Analyze

A GraphPlot object
View
Let’s make a simple Graph

sourceNodes = [ 1 1 1 2 2 3 3 4 5 5 6 7 ];
targetNodes = [ 2 4 8 3 7 4 6 5 6 8 7 8 ];
G = graph( sourceNodes , targetNodes )

G =

    graph with properties:
    Edges: [12x1 table]
    Nodes: [8x0 table]
P = plot(G);

sourceNodes = [1 1 1 2 2 3 3 4 5 5 6 7];
targetNodes = [2 4 8 3 7 4 6 5 6 8 7 8];
Plot a Graph

\[
\text{layout}(P, 'circle')
\]
Are these drawings of the same graph?
Plot a Graph

layout(P, 'layered')
Plot a Graph

```matlab
layout( P, 'force' );
```
Graphs in MATLAB

load('MinnesotaRoads');
plot(G);
Graphs in MATLAB

G.Nodes(1:7,:) 

ans =

<table>
<thead>
<tr>
<th>Longitude</th>
<th>Latitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>-97.207</td>
<td>49.001</td>
</tr>
<tr>
<td>-96.801</td>
<td>49</td>
</tr>
<tr>
<td>-95.957</td>
<td>49</td>
</tr>
<tr>
<td>-95.931</td>
<td>49</td>
</tr>
<tr>
<td>-95.766</td>
<td>49</td>
</tr>
<tr>
<td>-95.378</td>
<td>48.999</td>
</tr>
<tr>
<td>-97.2</td>
<td>48.972</td>
</tr>
</tbody>
</table>
P = plot(G, 'XData', G.Nodes.Longitude, 'YData', G.Nodes.Latitude);
### Useful Graph Algorithms

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>shortestpath</td>
<td>Shortest path between two single nodes</td>
</tr>
<tr>
<td>shortestpathtree</td>
<td>Shortest path tree from node</td>
</tr>
<tr>
<td>distances</td>
<td>Shortest path distances of all node pairs</td>
</tr>
<tr>
<td>bfsearch</td>
<td>Breadth-first graph search</td>
</tr>
<tr>
<td>dfsearch</td>
<td>Depth-first graph search</td>
</tr>
<tr>
<td>maxflow</td>
<td>Maximum flow in graph</td>
</tr>
<tr>
<td>conncomp</td>
<td>Connected graph components</td>
</tr>
<tr>
<td>minspantree</td>
<td>Minimum spanning tree of graph</td>
</tr>
<tr>
<td>toposort</td>
<td>Topological order of directed acyclic graph</td>
</tr>
<tr>
<td>isdag</td>
<td>Determine if graph is acyclic</td>
</tr>
<tr>
<td>transclosure</td>
<td>Transitive closure</td>
</tr>
<tr>
<td>transreduction</td>
<td>Transitive reduction</td>
</tr>
</tbody>
</table>
Graphs in MATLAB

\[ \text{P.labelnode}(\text{cityIDs}, \text{cityNames}) ; \]
Graphs in MATLAB

\texttt{P.labelnode(cityIDs, cityNames);}
Graphs in MATLAB

T = shortestpath(G,Minneapolis,Moorhead);
P.highlight(T,'EdgeColor','r);
Graphs in MATLAB

```matlab
T = shortestpath(G,Minneapolis,Moorhead);
P.highlight(T,'EdgeColor','r');
```
**Graphs in MATLAB**

```matlab
P.NodeCData = distances(G, Minneapolis);
title('Distance from Minneapolis (miles)');
colorbar
```
Graphs in MATLAB

```matlab
P.NodeCData = distances(G, Minneapolis);
title('Distance from Minneapolis (miles)');
colorbar
```
Minnesota gets a lot of snow.

You plow the snow
Your equipment is in Minneapolis
You don’t have to plow every road
Drivers must be able to get from every town to every other town

What is the least you must plow?

tree = minspantree(G,'root',minneapolis);
highlight(P,tree, 'LineWidth', 3);
Minnesota gets a lot of snow.

You plow the snow
Your equipment is in Minneapolis
You don’t have to plow every road
Drivers must be able to get from every town to every other town

What is the least you must plow?

```matlab
tree = minspantree(G,'root',minneapolis);
highlight(P,tree, 'LineWidth', 3);
```
Add-On Explorer

The File Exchange on MATLAB Central

About 20,000 submissions

An underused resource

Awareness

Complexity
Add-On Explorer
Add-On Explorer
Add-On Explorer
Add-On Explorer

Community Toolboxes

"JSON": "MATLAB"

JSONlib: a toolbox to read/write JSON files in MATLAB.

Library to handle 3D geometric primitives, create, transform, display, and make basic computations.

355 Downloads

GeoM:

GeoM2D:

Deep Neural Network

It provides deep learning tools for deep belief networks (DBN).

933 Downloads

355 Downloads

Community Apps

Floppy Bird for MATLAB

MATLAB edition of the very popular game "Floppy Bird."

156 Downloads

252 Downloads

SegmentTool: An Interactive GUI for Segmenting Images

Easily find the best approach to segmenting (masking) your image.

214 Downloads

An interactive environment for interactively segmenting medical images.

214 Downloads

Image Morphology

Cascade Trainer: Specify Ground Truth, Train a Detector

Interactively specify rectangular ROIs in a list of images and build new statistics classifiers.

105 Downloads

Compare GPU using standard numerical benchmarks in MATLAB.

105 Downloads

GPUBeans

Community Simulink Models

A PHOTOVOLTAIC PANEL MODEL IN MATLAB/SIMULINK

A simulink simulation model for a PV panel for estimating the PV array and PV maximum power.

159 Downloads

Grid-Connected PV Array

Simulink model of a grid-connected PV array using SimPowerSystems.

349 Downloads

Perturb and Observe (P&O) Algorithm for PV MPPT

Maximum power point tracker algorithm is implemented for PV system.

318 Downloads

256 Downloads

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UNITED KINGDOM

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Add-On Explorer

## geom3d Library

**Description:**
- A library to handle 3D geometric primitives, create, interact, display, and make basic computations.

**Features:**
- Creation of various shapes (3D points, 3D lines, planes, polyhedra) through an intuitive syntax (e.g., `createPlane(x1, y1, z1, x2, y2, z2)`).
- Intersection of planes, planes with a line or a plane with a sphere.
- Functions for 3D polygons and polyhedra: Create classical vertex-faces arrays, face array contains indices of vertices, and support faces with any number of vertices. Some basic models are provided (createOctahedron, createCuboid, etc.), as well as some computation (like the normal or centroid).

**Manipulation of Planar Transformation:**
- `RROT = createRotationOnXTHETA(THETA);`  
- `P3 = transformPoint3d(P1, RROT);`

- Direct drawing of shapes with specialized functions: `draw3d(x1, y1, z1, x2, y2, z2)` draws a line.

**Library Packages:**
- geom3d for general computation in 3d
- meshes3d for representation and manipulation of polyhedral meshes

**Additional Information:**
- Several functions require the geom3d package, available on the File Exchange.
- Additional help is provided in the geom3d.uicontrols and meshes3d.uicontrols files, as well as summary files like `points3d.m` or `lines3d.m`.

**Other Requirements:**
- Some functions require the geom3d library, also on the File Exchange (ID: 7644).
Add-On Manager

```matlab
>> demodrawTubularMesh
```
Add-On Explorer
Add-On Manager

```matlab
>> demoDrawTubularMesh
```
Add-On Manager
Add-On Manager

- Aerospace Blockset version 3.15
  - MathWorks Product
  - Installed on 21 September 2015
  - Learn More
  - Uninstall

- Aerospace Toolbox version 2.10
  - MathWorks Toolbox
  - Installed on 21 September 2015
  - Learn More
  - Uninstall

- Antenna Toolbox version 1.1
  - MathWorks Toolbox
  - Installed on 21 September 2015
  - Learn More
  - Uninstall

- Bioinformatics Toolbox version 4.5.2
  - MathWorks Toolbox
  - Installed on 21 September 2015
  - Learn More
  - Uninstall

- Communications System Toolbox version 6.1
  - MathWorks Toolbox
  - Installed on 21 September 2015
  - Learn More
  - Uninstall

- Computer Vision System Toolbox version 7.0
  - MathWorks Toolbox
  - Installed on 21 September 2015
  - Learn More
  - Uninstall
Add-On Explorer

I searched for “Vibration”
133 results

“Spectral”
512 results

“Machine Learning”
125 results
### Add-On Explorer

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration</td>
<td>133</td>
</tr>
<tr>
<td>Spectral</td>
<td>512</td>
</tr>
<tr>
<td>Machine Learning</td>
<td>125</td>
</tr>
<tr>
<td>Support Vector</td>
<td>226</td>
</tr>
<tr>
<td>Classify</td>
<td>411</td>
</tr>
<tr>
<td>Detect</td>
<td>1342</td>
</tr>
<tr>
<td>Control</td>
<td>3919</td>
</tr>
<tr>
<td>Control Phase</td>
<td>191</td>
</tr>
<tr>
<td>Love</td>
<td>26</td>
</tr>
<tr>
<td>Beauty</td>
<td>26</td>
</tr>
<tr>
<td>Truth</td>
<td>84</td>
</tr>
<tr>
<td>Beer</td>
<td>10</td>
</tr>
<tr>
<td>Monkey</td>
<td>3</td>
</tr>
<tr>
<td>Yogurt</td>
<td>0</td>
</tr>
</tbody>
</table>

Don’t start doing this when you have a deadline!
MATLAB Execution Engine

MATLAB

Language
R2015b
“LXE”

Math

Graphics
R2014b
MATLAB Execution Engine

Old system had two different execution mechanisms – a JIT and an Interpreter. New system has a single execution mechanism.

Old JIT was designed for FORTRAN-like constructs within MATLAB. New JIT is designed for the entire MATLAB language.

Old system had a monolithic architecture that was difficult to extend. New system has a Modular, Thread-safe, and Platform re-targetable architecture.
MATLAB Execution Engine
Performance Improvement Highlights

Econometrics Toolbox: American Basket Demo executes 60% faster
Image processing with active contours executes 32% faster
SVM classification for Machine Learning executes 12% faster
Examples used in “Speeding up MATLAB” webinar execute 30% faster
k-NN classification for Machine Learning executes 37% faster
Machine Learning classification executes 25% faster
Image Processing executes 15% faster
Performance in Object-Oriented MATLAB Code on File Exchange executes 10-40% faster
Wireless Application demo executes 50% faster
Application Level Benchmarks

99% on par or faster with LXE
64% more than 10% faster
Core and Toolbox UPS tests

Tests slower with the LXE
(10%)

Tests faster with the LXE
(55%)

~ Same (35%)

90% on par or faster with LXE
55% more than 10% faster
39% more than 25% faster

Lower-level tests show more variability
MATLAB Execution Engine
Summary

R2015b runs MATLAB programs faster than previous releases.

We will continue to increase performance.

We will add new features more easily and more quickly.
What’s New in MATLAB 2015