MATLAB EXPO 2016

What’s New in MATLAB

Ned Gulley
Features

• Live Editor
• Native string
• Timetable
• Moving averages
• Add-Ons
• MATLAB Drive
• MATLAB Online
• Datastore
• Functions in scripts
• App Designer
Features

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- Add-Ons
- MATLAB Drive
- MATLAB Online
- Datastore
- Functions in scripts
- App Designer

Highlights from 2016a and 2016b
Live Scripts
Football Analysis

Including games from English, German, and Italian leagues.

```matlab
db = sqlite('soccer.sqlite');
query = 'SELECT date, home_team_goal, away_team_goal, goal FROM Match';
goals = fetch(db, char(query));

t = cell2table(goals, ...  
    'VariableNames', ...  
    {'Date', 'HomeScore', 'AwayScore', 'GoalEventStr'});

t(1:3,:)
```

```
ans =

<table>
<thead>
<tr>
<th>Date</th>
<th>HomeScore</th>
<th>AwayScore</th>
<th>GoalEventStr</th>
</tr>
</thead>
<tbody>
<tr>
<td>'2008-08-17 00:00:00'</td>
<td>1</td>
<td>1</td>
<td>'&lt;goal&gt;&lt;val'</td>
</tr>
<tr>
<td>'2008-08-16 00:00:00'</td>
<td>1</td>
<td>0</td>
<td>'&lt;goal&gt;&lt;val'</td>
</tr>
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</tr>
</tbody>
</table>
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Football Analysis

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</tr>
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Football Analysis

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query = 'SELECT date,home_team_goal,away_team_goal,goal FROM Match'
goals = fetch(db,char(query));

t = cell2table(goals, ...
    'VariableNames', ...
    {'Date','HomeScore','AwayScore','GoalEventStr'});

t(1:3,:)
```

```
ans =
     Date       HomeScore       AwayScore
     '2008-08-17 00:00:00'     1         1       '<goal><val
     '2008-08-16 00:00:00'     1         0       '<goal><val
     '2008-08-16 00:00:00'     0         1       '<goal><val
```
```markdown
Who scored the most?

```markdown
<table>
<thead>
<tr>
<th>Date</th>
<th>HomeScore</th>
<th>AwayScore</th>
<th>GoalEventStr</th>
</tr>
</thead>
<tbody>
<tr>
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<td>1</td>
<td>1</td>
<td>'&lt;goal&gt;&lt;val'</td>
</tr>
<tr>
<td>'2008-08-16 00:00:00'</td>
<td>1</td>
<td>0</td>
<td>'&lt;goal&gt;&lt;val'</td>
</tr>
<tr>
<td>'2008-08-16 00:00:00'</td>
<td>0</td>
<td>1</td>
<td>'&lt;goal&gt;&lt;val'</td>
</tr>
</tbody>
</table>
```

```markdown
sum(t.HomeScore)
ans = 13164

sum(t.AwayScore)
ans = 9972
```
Native Strings

Regular Expressions
>>> s = string(t.GoalEventStr(4))
Native Strings vs. Regular Expressions

tk = regexp(s,'<elapsed>(.*?)</elapsed>','tokens');
g = zeros(size(tk))
for i = 1:length(tk)
    g(i) = str2num(tk{i}{1})
end

s = string(s);

\[ g = s.extractBetween('<elapsed>', '</elapsed>').double \]
```python
histogram([t.GoalTime[:]])
xlabel('Time of Goal')
ylabel('Number of Goals')
```
First Half vs. Second Half Goals

```python
histogram([t.GoalTime[::]], [0 45.5 90])
xlabel('Time of Goal')
ylabel('Number of Goals')
```
t.Date = datetime(t.Date);
tt = table2timetable(t);
tt = sortrows(tt,'Date');

allGoals = tt.HomeScore + tt.AwayScore;
plot(tt.Date,allGoals,'o')
grid
title('Goal Count')
xlabel('Date')
ylabel('Number of Goals')
Moving Average

\[ xf = \text{filter(ones(1,7)/7, 1, x);} \]

\[ xf = \text{movmean(x, 7);} \]
Moving Average

```matlab
s = timerange('01-Aug-2008','01-Jun-2009');
allGoals = tt.HomeScore(s) + tt.AwayScore(s);

n = 60;
movGoals = movmean(allGoals,n);
plot(tt.Date(s),movGoals,"o")

ylim([1.5 4])
grid
title(sprintf('Moving Average (2008-2009) n=%d',n))
xlabel('Date')
ylabel('Number of Goals')
```
Moving Average

```r
s = timerange('01-Aug-2008', '01-Jun-2009');
allGoals = tt.HomeScore(s) + tt.AwayScore(s);

n = 60;
movGoals = movmean(allGoals, n);
plot(tt.Date(s), movGoals, 'o')

ylim([1.5 4])
grid

title(sprintf('Moving Average (2008-2009) n=%d', n))
xlabel('Date')
ylabel('Number of Goals')
```
Moving Average

```r
s = timerange('01-Aug-2008', '01-Jun-2009');
allGoals = tt.HomeScore(s) + tt.AwayScore(s);

n = 60;
movGoals = movmean(allGoals, n);
plot(tt.Date(s), movGoals, 'o')
```
Moving Statistics

movmean
movsum
movmedian
movmax
movmin
movvar
movstd
MATLAB Add-Ons
Bioinformatics Toolbox R2017a by MathWorks

Read, analyze, and visualize genomic and proteomic data
sequence browsers, spatial heatmaps, and clustergrams. The toolbox also provides statistical techniques for detecting peaks, imputing values for missing data, and selecting features. You can combine toolbox functions:

- HeatMap - Display heat map of matrix data and create HeatMap object
- HeatMap object - Object containing matrix and heat map display properties

MathWorks Toolbox

Customizable Heat Maps version 1.5 by Ameya Deoras

Visualize data as a heatmap with many customizable options.

******** Updated for 2014b ********
HEATMAP displays a matrix as an image whose color intensities reflect the magnitude of its values. In addition, it enables you to specify the following:

- Heatmap Examples - This script demonstrates the capabilities of the heatmap vis...
- fx heatmap(mat, xlabel, ylabel, textmat, varargin) - HEATMAP displays a matrix as a heat...

Toolbox

Visualize matrix by a heatmap version 1.0 by zhang

FCOLORMAT allows you to visualize the matrix with color gradient

Collection
**Updated for 2014b**

**HEATMAP** displays a matrix as an image whose color intensities reflect the magnitude of its values. In addition, it enables you to specify the following properties:

* X- and Y-axes tick labels:
  Display the row/column indices or any other numeric or text labels. X-axis tick labels can even be rotated.

* Text labels:
  Overlay the heatmap image with formatted text labels. The text labels can be derived from the original numeric matrix or a different matrix or cell array for displaying another dimension of data. You can control the font size and font color of the labels. The labels update automatically with zooming, panning or resizing the figure.

* Custom color maps:
  Use MATLAB's default color maps or specify your own. The function provides two additional color maps - "money" (shown in the example image) and "red" (a color map of red color intensities). Specify Linear or Logarithmic color maps and the number of color levels. You can even use different color maps for different heatmaps within a figure.

* Other configurable parameters such as grid lines, color bars.

For detailed examples, see the associated document heatmap_examples.m

**NOTE:** If using rotated tick labels, HEATMAP will resize the axes to make room for the tick labels. When overwriting existing heatmap plots with a new heatmap, use CLF to first clear the figure. See heatmap_examples for an illustration.
Customizable Heat Maps

By Amaya Decxas
24 May 2006 (Updated 01 Sep 2016)

Visualize data as a heatmap with many customizable options.

Watch the File | View in Add-on Tool

** File Information **

Description:******** Updated for 2014b ********

HEATMAP displays a matrix as an image whose color intensities reflect the magnitude of its values. In addition, it enables you to specify the following properties:

* X- and Y-axis grid labels
Display the column names as any other numeric or text labels. X-axis tick labels can even be rotated.

* Text labels:
Overlay the heatmap image with formatted text labels. The text labels can be derived from the original numeric matrix or a different matrix or cell array for displaying another dimension of data. You can control the font size and font color of the labels. The labels update automatically with zooming, panning or resizing the figure.

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Acknowledgements: This file inspired "An Introduction to Dataset Arrays, Heatmap Modeling With Matlab, Natural Gas Storage Valuation, Streamgraph, and Scatterplot."
Scoring Heat Map

What are the most common goal scoring scenarios?

```matlab
labels = string(0:5);
heatmap(a(1:6,1:6),labels,labels,'%3d');

xlabel('Away Team Goals')
ylabel('Home Team Goals')
set(gca,'XAxisLocation','top')
axis square
colorbar
```
MATLAB Drive
U.S. Naming Records 1880-2015

<table>
<thead>
<tr>
<th>Name</th>
<th>Date Modified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mary</td>
<td>7/065, 1880</td>
</tr>
<tr>
<td>Anna</td>
<td>2/604, 1880</td>
</tr>
<tr>
<td>Emma</td>
<td>3/003, 1880</td>
</tr>
<tr>
<td>Elizabeth</td>
<td>1/939, 1880</td>
</tr>
<tr>
<td>Minnie</td>
<td>1/746, 1880</td>
</tr>
<tr>
<td>Margaret</td>
<td>1/578, 1880</td>
</tr>
<tr>
<td>Ida</td>
<td>1/472, 1880</td>
</tr>
<tr>
<td>Alice</td>
<td>1/414, 1880</td>
</tr>
<tr>
<td>Bertha</td>
<td>1/320, 1880</td>
</tr>
<tr>
<td>Sarah</td>
<td>1/288, 1880</td>
</tr>
<tr>
<td>Annie</td>
<td>1/258, 1880</td>
</tr>
<tr>
<td>Clara</td>
<td>1/226, 1880</td>
</tr>
<tr>
<td>Ella</td>
<td>1/156, 1880</td>
</tr>
<tr>
<td>Florence</td>
<td>1/063, 1880</td>
</tr>
<tr>
<td>Cora</td>
<td>1/045, 1880</td>
</tr>
<tr>
<td>Martha</td>
<td>1/040, 1880</td>
</tr>
<tr>
<td>Laura</td>
<td>1/012, 1880</td>
</tr>
<tr>
<td>Nellie</td>
<td>1/995, 1880</td>
</tr>
<tr>
<td>Grace</td>
<td>9/82, 1880</td>
</tr>
<tr>
<td>Carrie</td>
<td>9/49, 1880</td>
</tr>
<tr>
<td>Maude</td>
<td>8/58, 1880</td>
</tr>
<tr>
<td>Mabel</td>
<td>8/88, 1880</td>
</tr>
<tr>
<td>Bessie</td>
<td>7/96, 1880</td>
</tr>
<tr>
<td>Jennie</td>
<td>7/93, 1880</td>
</tr>
</tbody>
</table>

(yob1880.txt)
More fun with Strings...

```python
filepaths = string('names/yob') + (1880:2015) + string('.txt')
```

```
filepaths =
    "names/yob1880.txt"
    "names/yob1881.txt"
    "names/yob1882.txt"
    "names/yob1883.txt"
    "names/yob1884.txt"
    "names/yob1885.txt"
    "names/yob1886.txt"
    "names/yob1887.txt"
    "names/yob1888.txt"
    "names/yob1889.txt"
    "names/yob1890.txt"
    "names/yob1891.txt"
    "names/yob1892.txt"
    "names/yob1893.txt"
    "names/yob1894.txt"
    "names/yob1895.txt"
    "names/yob1896.txt"
```
```r
(dat = datastore('names/yob*.txt', ...,
  'ReadVariableNames', false, ...
  'VariableNames', c('Name', 'Gender', 'Number', 'Year')));

tallNames = tall(dat)

tallNames =

M x 4 tall table

<table>
<thead>
<tr>
<th>Name</th>
<th>Gender</th>
<th>Number</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>'Mary'</td>
<td>'F'</td>
<td>7065</td>
<td>1880</td>
</tr>
<tr>
<td>'Anna'</td>
<td>'F'</td>
<td>2604</td>
<td>1880</td>
</tr>
<tr>
<td>'Emma'</td>
<td>'F'</td>
<td>2003</td>
<td>1880</td>
</tr>
<tr>
<td>'Elizabeth'</td>
<td>'F'</td>
<td>1939</td>
<td>1880</td>
</tr>
<tr>
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<td>'F'</td>
<td>1746</td>
<td>1880</td>
</tr>
<tr>
<td>'Margaret'</td>
<td>'F'</td>
<td>1578</td>
<td>1880</td>
</tr>
<tr>
<td>'Ida'</td>
<td>'F'</td>
<td>1472</td>
<td>1880</td>
</tr>
<tr>
<td>'Alice'</td>
<td>'F'</td>
<td>1414</td>
<td>1880</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>
```
Talk
Application Track 1, 11.15
Big Data
Demo
Big Data with MATLAB
```python
dat = datastore('names/yob*.txt',
    'ReadVariableNames',false,
    'VariableNames',
    {'Name', 'Gender', 'Number', 'Year'});

names = readall(dat)
```

<table>
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<th>Number</th>
<th>Year</th>
</tr>
</thead>
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<td>F</td>
<td>1320</td>
<td>1880</td>
</tr>
<tr>
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<td>F</td>
<td>1288</td>
<td>1880</td>
</tr>
<tr>
<td>Annie</td>
<td>F</td>
<td>1258</td>
<td>1880</td>
</tr>
<tr>
<td>Clara</td>
<td>F</td>
<td>1226</td>
<td>1880</td>
</tr>
<tr>
<td>Ella</td>
<td>F</td>
<td>1156</td>
<td>1880</td>
</tr>
<tr>
<td>Florence</td>
<td>F</td>
<td>1063</td>
<td>1880</td>
</tr>
</tbody>
</table>
keep = names.Name=='Aloysius';
plot(names.Year(keep), names.Number(keep), 'LineWidth', 3);
grid
title('Baby Name Popularity')
legend({'Aloysius','Location','NorthWest'})
xlabel('year')
ylabel('births')
ylim([0 300])
```matlab
cla
hold on
plotNames('Aloysius', names)
plotNames('Cristiano', names)
hold off
legend({'Aloysius', 'Cristiano'}, 'Location', 'northwest')
```
function plotNames(inputName, names)

% Local function for plotting names

keep = (names.Name==inputName)&&(names.Gender=='M');
plot(names.Year(keep), names.Number(keep),'LineWidth',3);
grid on
title('Baby Name Popularity')
xlabel('year')
ylabel('births');
end
Zooming in Live Script Plots

```matlab
name = 'Cristiano';
keep = names.Name==name;
hold on
plot(names.Year(keep), names.Number(keep),'LineWidth',3);
legend({'Aloysius','Cristiano'},'Location','NorthWest')
hold off
```

![Baby Name Popularity Chart](chart.png)
plotNames('Wayne', names)
Can you predict a child’s football career based solely on their name?

Jamie  Lionel  Jos
Wayne  ???  Raheem
Sham  Aloysius  Diego
Can you predict a child’s football career based solely on their name?

Talk
Application Track 1, 12.15
Machine Learning and Deep Learning

Demo
Machine Learning with MATLAB
App Designer
The image shows the MATLAB App Designer interface with a component library on the left and a canvas on the right. The canvas contains a blank figure window with gridlines and a label at the top labeled "Title." The label properties panel is open, showing text settings for the label. The label text is "Label," with a font set to "Helvetica." The configuration settings include text, size, style, and color options.
Baby Name Popularity

Read about Graphics Support in R2016b.
```matlab
classdef BabyNames < matlab.apps.AppBase
    % Properties that correspond to app components
    properties (Access = public)
        UIFigure
        BabyNamePopularityLabel
        UIAxes
        EntertheNamePanel
        GenderButtonGroup
        MaleButton
        FemaleButton
        NameEditField
        CloseButton
    end

    % Properties (Access = private)
    allBabyNames
    end

    % Methods (Access = private)
    % Code that executes after component creation
    function startupFcn(app)
        load('BabyNamesData.mat');
        app.allBabyNames = names; % Highlighted line
    end

    % Value changed function: NameEditField
    function NameEditFieldValueChanged(app, event)
        theName = app.NameEditField.Value;
        names = app.allBabyNames;
        selectedGenderButton = app.GenderButtonGroup.SelectedObject.Text;
        gender = selectedGenderButton(i);
        keep = names.Name==theName && names.Gender==gender;
        plot(app.UIAxes,names.Year(keep), names.Number(keep), 'LineWidth',3); % Highlighted line
    end

    % Selection changed function: GenderButtonGroup
    function GenderButtonGroupsSelectionChanged(app, event)
        % Highlighted line
    end

    % Button pushed function: CloseButton
    function CloseButtonPushed(app, event)
        close(app.UIFigure);
    end
end
```
Baby Name Popularity

[Graph showing the number of births over years for a selected name]

Enter the Name

Gender

- Male
- Female

Close
Finishing up…

• Live Editor
• Native string
• Timetable
• Moving averages
• Add-Ons
• MATLAB Drive
• MATLAB Online
• Datastore
• Functions in scripts
• App Designer
<table>
<thead>
<tr>
<th>Time</th>
<th>Application Track 1</th>
<th>Application Track 2</th>
<th>Introductory Sessions</th>
<th>Master Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:15</td>
<td><strong>Big Data</strong></td>
<td>What’s New in Simulink Release R2016a and R2016b</td>
<td>Introduction to MATLAB</td>
<td>Signal Processing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MATLAB and Advanced Analytics at Shell</td>
<td>Fast-Paced Development in F1 Control and Analysis Systems</td>
<td></td>
</tr>
<tr>
<td>11:45</td>
<td></td>
<td></td>
<td>Introduction to Parallel Computing</td>
<td>Hardware-in-the-Loop: Real-Time Simulation</td>
</tr>
<tr>
<td>12:15</td>
<td><strong>Machine Learning and Deep Learning</strong></td>
<td>New Capabilities in Testing</td>
<td>Introduction to Simulink and Stateflow</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Connecting to Hardware and Rapid Prototyping</td>
<td></td>
</tr>
<tr>
<td>12:45</td>
<td>Lunch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13:15</td>
<td>Lunchtime Talk - Science Capital</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14:00</td>
<td>The Adoption of MATLAB Apps and Toolboxes at Jaguar Land Rover</td>
<td>Physical Modelling Integration and Cosimulation in a Real-Time Environment</td>
<td>Introduction to Simulink and Stateflow</td>
<td>Simulink for Teams: High-Productivity Workflows</td>
</tr>
<tr>
<td>14:30</td>
<td><strong>Developing and Sharing MATLAB Apps and Toolboxes</strong></td>
<td>Connecting to Hardware and Rapid Prototyping</td>
<td>Introduction to Simulink and Stateflow</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Connecting to Hardware and Rapid Prototyping</td>
<td></td>
</tr>
<tr>
<td>15:15</td>
<td>Break</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16:15</td>
<td>Modelling and Simulating RF Sensor Systems</td>
<td>Verification of Automatically Generated Code</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>Application Track 1</td>
<td>Application Track 2</td>
<td>Introductory Sessions</td>
<td>Master Classes</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------</td>
<td>---------------------</td>
<td>-----------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>11:15</td>
<td>Big Data</td>
<td>What’s New in Simulink Release R2016a and R2016b</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td>Introductory Sessions</td>
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<td></td>
</tr>
<tr>
<td>11:45</td>
<td>Big Data</td>
<td>MATLAB and Advanced Signal Processing</td>
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<td>Signal Processing</td>
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<td>What’s New in Simulink Release R2016a and R2016b</td>
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<td>Introductory Sessions</td>
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<td>Introduction to Parallel Computing</td>
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<td>12:45</td>
<td>Lunch</td>
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<td>13:15</td>
<td>Lunchtime Talk - Science Capital</td>
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<td>14:00</td>
<td>The Adoption of MATLAB Apps and Toolboxes at Jaguar Land Rover</td>
<td>Physical Modelling Integration and CoSimulation in a Real-Time Environment</td>
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<td>14:30</td>
<td>Developing and Sharing MATLAB Apps and Toolboxes</td>
<td>Connecting to Hardware and Rapid Prototyping</td>
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<td>Simulink for Teams: High-Productivity Workflows</td>
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<td>Break</td>
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<td>15:45</td>
<td>MATLAB Algorithm Development and Verification for Eurofighter Typhoon Praetorian</td>
<td>Applying MathWorks Tools to Automotive Embedded Software Development</td>
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<td>Developing Robust MATLAB Code and Apps</td>
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<td>Modelling and Simulating RF Sensor Systems</td>
<td>Verification of Automatically Generated Code</td>
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<td>16:45</td>
<td>Lunch</td>
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That is all.