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
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- Functions in scripts
- App Designer

Highlights from 2016a and 2016b
Live Scripts
Football Analysis

Including games from English, German, and Italian leagues.

```sql
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,:)
```
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,:)
```

<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>
<tr>
<td>'2008-08-16 00:00:00'</td>
<td>0</td>
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Football Analysis

Including games from English, German, and Italian leagues.

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

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

t(1:3,:)

ans =

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<th>AwayScore</th>
<th>GoalEventStr</th>
</tr>
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</table>
| '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'  


```matlab
{'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

Who scored the most?

sum(t.HomeScore)
ans = 13164

sum(t.AwayScore)
ans = 9972
Native Strings

Regular Expressions

No
s = string(t.GoalEventStr(4))
Native Strings vs. Regular Expressions

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

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

histogram([t.GoalTime[::],[0 45.5 90])
xlabel('Time of Goal')
ylabel('Number of Goals')
```
import datetime

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

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

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

```plaintext
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')
```

```r
g ylim([1.5 4])
grid
title(s)
xlabel()
ylabel()
```

**Goal Count Moving Average, n=7**

- **Number of Goals**
  - Values range from 1.5 to 4.0.
- **Date**
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.

- `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 scripts demonstrates the capabilities of the heatmap vis...
- `heatmap(mat, xlab, ylab, textmat, varargin)` - HEATMAP displays a matrix as a heat...

Toolbox

Visualize matrix by a heatmap version 1.0 by zhang

PCOLORMAT allows you to visualize the matrix with color gradient

Collection
**Customizable Heat Maps** version 1.5 by Ameya Deoras

Visualize data as a heatmap with many customizable options.

**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-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 Ortega
24 May 2008 (Updated 01 Sep 2016)

Visualize data as a heatmap with many customizable options.

Watch this File | View in AddOn Explorer

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 tick labels
  Display the main column indices or any other numeric or text labels. X-axis tick labels can even be rotated.
* Text labels
  Overlap 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 images) and "red" (a color map of red color intensities). Specify Linear or Logarithmic color mappings 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 overriding existing heatmap plots with a new heatmap, use CLF to first clear the figure. See heatmaps Examples for an illustration.

Acknowledgements

This file inspired: An Introduction To Dataset Arrays, Heatmap Modeling With Matlab, Natural Gas Storage Valuation, Stagelength, and Scatterplots.

Highlights from

Customizable Heat Maps

Heatmap Examples

Compare heatmaps, for example,

HEATMAP displays a matrix as a heatmap image

View all files
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

Ned's Files

- goal_analysis.mlx 3 KB 9/27/2016 4:48 PM
- france.mlx 66 KB 9/27/2016 4:37 PM
- flags.ml 3 KB 9/27/2016 4:37 PM
- driving_up_and_... 4 KB 9/20/2016 11:06 AM
- driving.m 1 KB 9/20/2016 11:06 AM
Football Analysis

Including games from English, German, and Italian leagues.

```matlab
% SQLite database connection
db = sqlite('soccer.sqlite');
query = 'SELECT date,home_team,away_team,goal FROM Match WHERE league_id=1729 OR goals = fetch(db, char(query));

% Create table for goals
goals = table(home_team,away_team,goal);

t = cell2table(goals,...'

% Who scored the most?

% Add a new GoalTime column to the table.

% Centralizing the data
```
U.S. Naming Records 1880-2015
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"
```
dat = datastore('names/yob*.txt',...
    'ReadVariableNames',false, ...
    'VariableNames',{'Name','Gender','Number','Year'});
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)
	names =

<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>
<td>'Minnie'</td>
<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>'Bertha'</td>
<td>'F'</td>
<td>1320</td>
<td>1880</td>
</tr>
<tr>
<td>'Sarah'</td>
<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>
```
```r
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])
```

Baby Name Popularity

![Graph showing baby name popularity over time, with a peak around 1920.](image)
plotNames('Aloysius', names)
plotNames('Cristiano', names)
hold off
legend({'Aloysius', 'Cristiano'}, 'Location', 'northwest')
Functions in Scripts

```matlab
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
```
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
```matlab
classdef BabyNames < matlab.apps.AppBase
    % Properties that correspond to app components
    properties (Access = public)
        UIFigure      matlab.ui.figure
        BabyNamePopularityLabel  matlab.ui.control.Label
        UIAxes         matlab.ui.control.UIAxes
        EntertheNamePanel  matlab.ui.container.Panel
        GenderButtonGroup  matlab.ui.container.ButtonGroup
        MaleButton       matlab.ui.control.RadioButton
        FemaleButton     matlab.ui.control.RadioButton
        NameEditfield   matlab.ui.control.Editfield
        closeButton     matlab.ui.control.Button
    end

    properties (Access = private)
        allBabyNames
    end

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

        % Value changed function: NameEditField
        function NameEditFieldValueChanged(app, event)
            theName = app.NameEditField.Value;
            names = app.allBabyNames;
            selectedGenderButton = app.GenderButtonGroup.SelectedObject.Text;
            gender = app.GenderButtonGroup();
            keep = names.Name==theName & names.Gender==gender;
            plot(app.UIAxes,names.Year(keep), names.Number(keep),'LineWidth',3);
            legend(app.UIAxes,[theName],{'Location', 'Northwest'});
        end

        % Selection changed function: GenderButtonGroup
        function GenderButtonGroupSelectionChanged(app, event)
        end

    end

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

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></td>
</tr>
<tr>
<td>11:45</td>
<td>MATLAB and Advanced Analytics at Shell</td>
<td>Fast-Paced Development in F1 Control and Analysis Systems</td>
<td>Introduction to Parallel Computing</td>
<td>Hardware-in-the-Loop: Real-Time Simulation</td>
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<td></td>
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<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></td>
<td>Simulink for Teams: High-Productivity Workflows</td>
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<tr>
<td>14:30</td>
<td><strong>Developing and Sharing MATLAB Apps and Toolboxes</strong></td>
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<td><strong>Verification of Automatically Generated Code</strong></td>
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That is all.