

21+ MATLAB Features You Need Now!

This is a quick summary of the features covered in the talk 21 MATLAB Features You Need Now.

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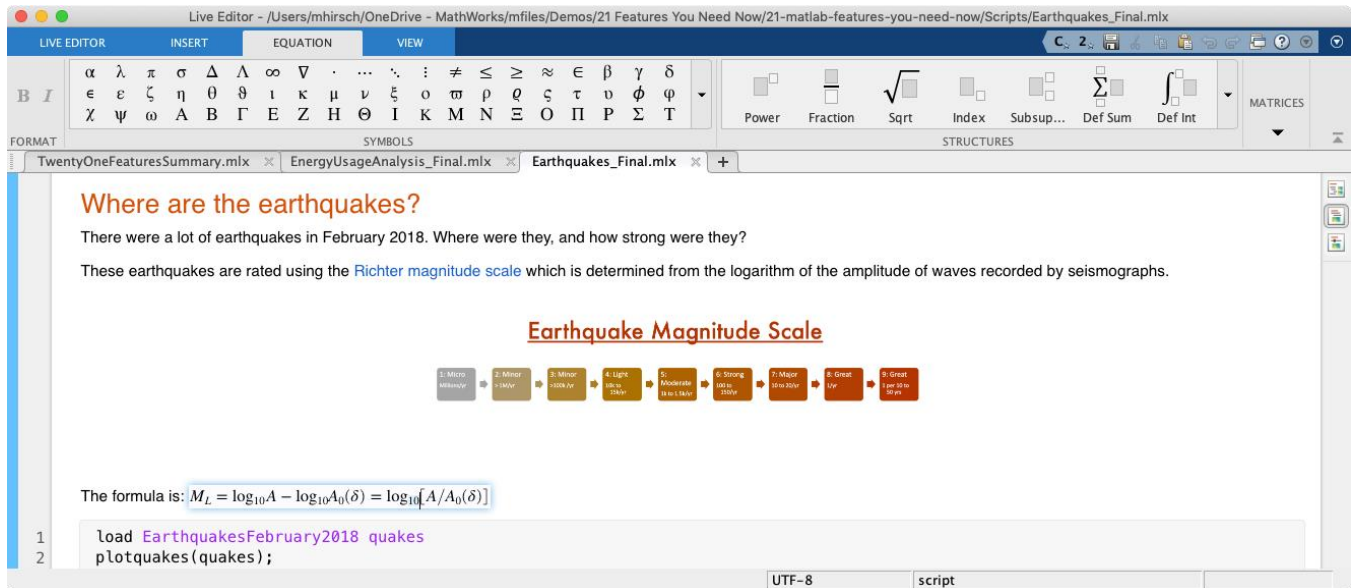
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Live Editor

You can create scripts that combine code, output, and formatted text with the [Live Editor](#). In fact, this document was created with the Live Editor. Some of our favorite features of the Live Editor are:

Formatted text, images, and equations

You can use formatted text and insert images and equations. There's a really nice equation editor, or you can use LaTeX if you prefer:



The screenshot shows the MATLAB Live Editor interface. The title bar indicates the file path: `Live Editor - /Users/mhirsch/OneDrive - MathWorks/mfiles/Demos/21 Features You Need Now/21-matlab-features-you-need-now/Scripts/Earthquakes_Final.mlx`. The interface includes a ribbon with tabs for **LIVE EDITOR**, **INSERT**, **EQUATION**, and **VIEW**. The **FORMAT** section contains a rich text editor with various symbols and formatting options. The **STRUCTURES** section includes mathematical symbols like Power, Fraction, Sqrt, Index, Subsup..., Def Sum, and Def Int. The **MATRICES** section is also visible.


The main content area displays a document with the following text:

Where are the earthquakes?

There were a lot of earthquakes in February 2018. Where were they, and how strong were they?

These earthquakes are rated using the **Richter magnitude scale** which is determined from the logarithm of the amplitude of waves recorded by seismographs.

Earthquake Magnitude Scale



The formula is: $M_L = \log_{10} A - \log_{10} A_0(\delta) = \log_{10} [A/A_0(\delta)]$

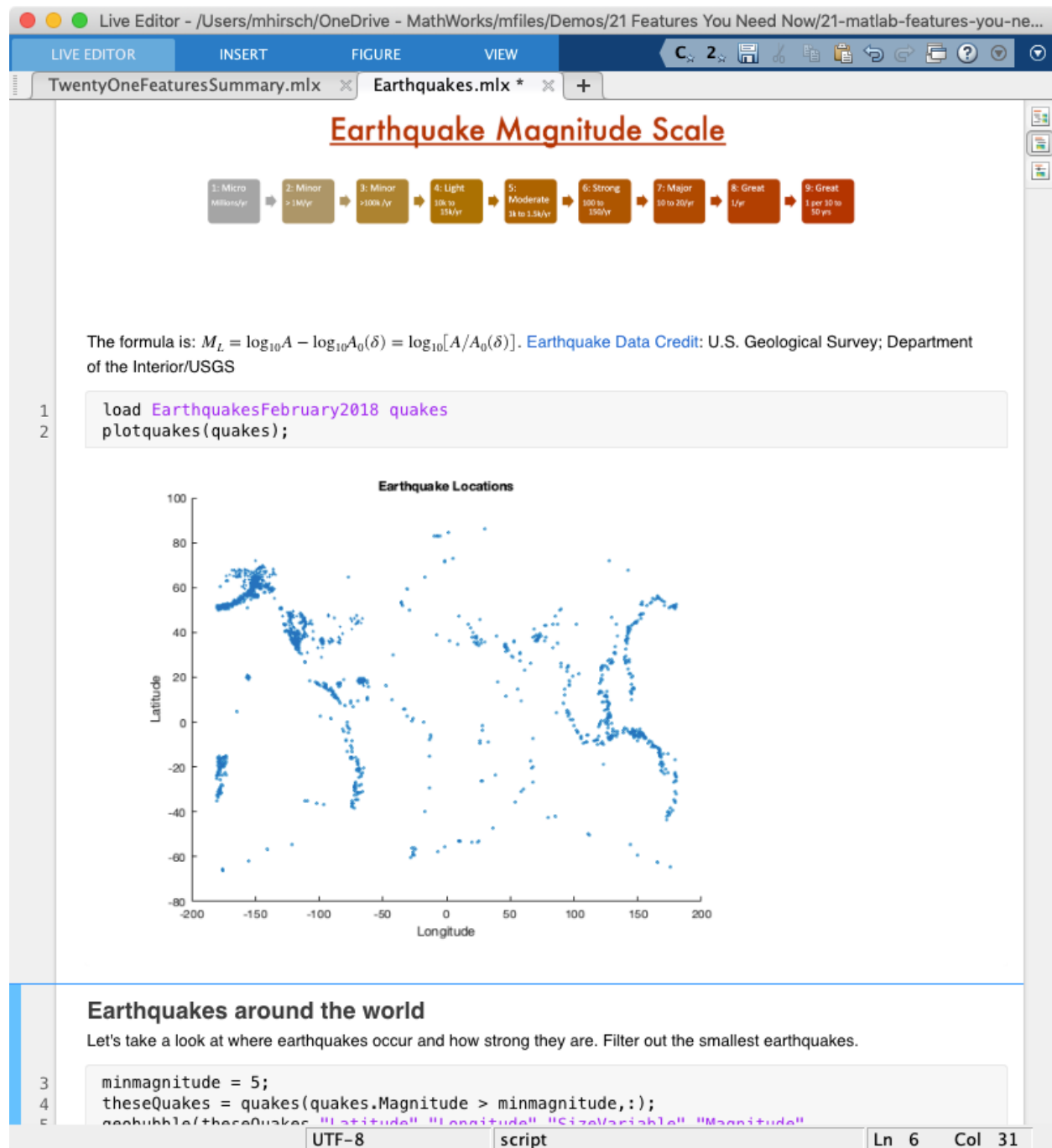
At the bottom, a code block is visible with the following MATLAB code:

```
1 load EarthquakesFebruary2018 quakes
2 plotquakes(quakes);
```

The status bar at the bottom right shows the encoding as **UTF-8** and the file type as **script**.

Output on right or inline

Output appears immediately adjacent to your code, either below or side-by-side:



The screenshot shows the MATLAB Live Editor interface. At the top, there are tabs for 'LIVE EDITOR', 'INSERT', 'FIGURE', and 'VIEW'. Below the tabs, there are two open files: 'TwentyOneFeaturesSummary.mlx' and 'Earthquakes.mlx *'. The main workspace contains the following content:

Earthquake Magnitude Scale

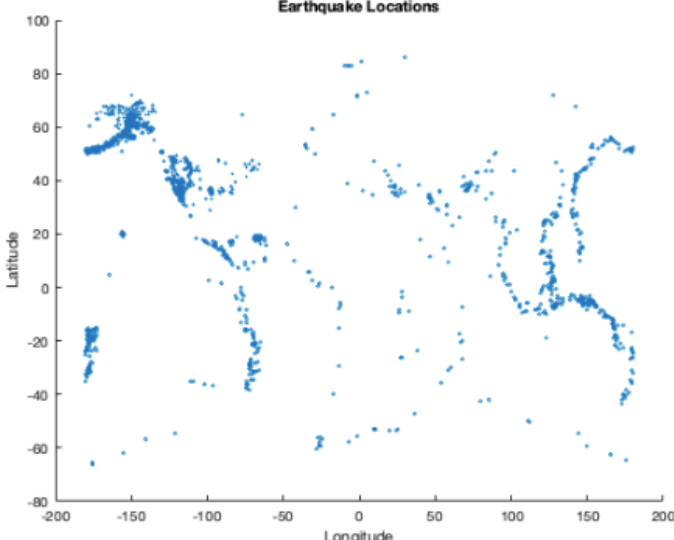
A diagram showing the Earthquake Magnitude Scale from 1 to 9. Each magnitude is represented by a colored box with its name and frequency:

- 1: Micro (Millions/yr)
- 2: Minor (>1 M/yr)
- 3: Minor (>100k/yr)
- 4: Light (10k to 1M/yr)
- 5: Moderate (1k to 1.5k/yr)
- 6: Strong (100 to 150/yr)
- 7: Major (10 to 20/yr)
- 8: Great (1/yr)
- 9: Great (1 per 50 to 50/yr)

The formula is: $M_L = \log_{10}A - \log_{10}A_0(\delta) = \log_{10}[A/A_0(\delta)]$. [Earthquake Data Credit](#): U.S. Geological Survey; Department of the Interior/USGS

```
1 load EarthquakesFebruary2018 quakes
2 plotquakes(quakes);
```

Earthquake Locations



Earthquakes around the world

Let's take a look at where earthquakes occur and how strong they are. Filter out the smallest earthquakes.

```
3 minmagnitude = 5;
4 theseQuakes = quakes(quakes.Magnitude > minmagnitude,:);
5 scatter(theseQuakes, "Latitude", "Longitude", "SizeVariable", "Magnitude")
```

UTF-8 script Ln 6 Col 31

Live Editor - /Users/mhirsch/OneDrive - MathWorks/mfiles/Demos/21 Features You Need Now/21-matlab-features-you-need-now/Earthquakes.mlx

LIVE EDITOR INSERT FIGURE VIEW C 2

TwentyOneFeaturesSummary.mlx Earthquakes.mlx +

Where are the earthquakes?

There were a lot of earthquakes in February 2018. Where were they, and how strong were they?

These earthquakes are rated using the **Richter magnitude scale** which is determined from the logarithm of the amplitude of waves recorded by seismographs.

Earthquake Magnitude Scale

1. Micro 1/1000 yr	2. Minor 1/100 yr	3. Minor 1/10 yr	4. Light 1/10 to 10 yr	5. Moderate 1/10 to 100 yr	6. Strong 1/10 to 1000 yr	7. Major 1/10 to 10000 yr	8. Great 1/100 to 1000 yr	9. Great 1 per 1000 to 10 yr
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The formula is: $M_L = \log_{10} A - \log_{10} A_0(\delta) = \log_{10} [A/A_0(\delta)]$. Earthquake Data Credit: U.S. Geological Survey; Department of the Interior/USGS

```

1  load EarthquakesFebruary2018 quakes
2  plotquakes(quakes);

```

Earthquakes around the world

Let's take a look at where earthquakes occur and how strong they are. Filter out the smallest earthquakes.

```

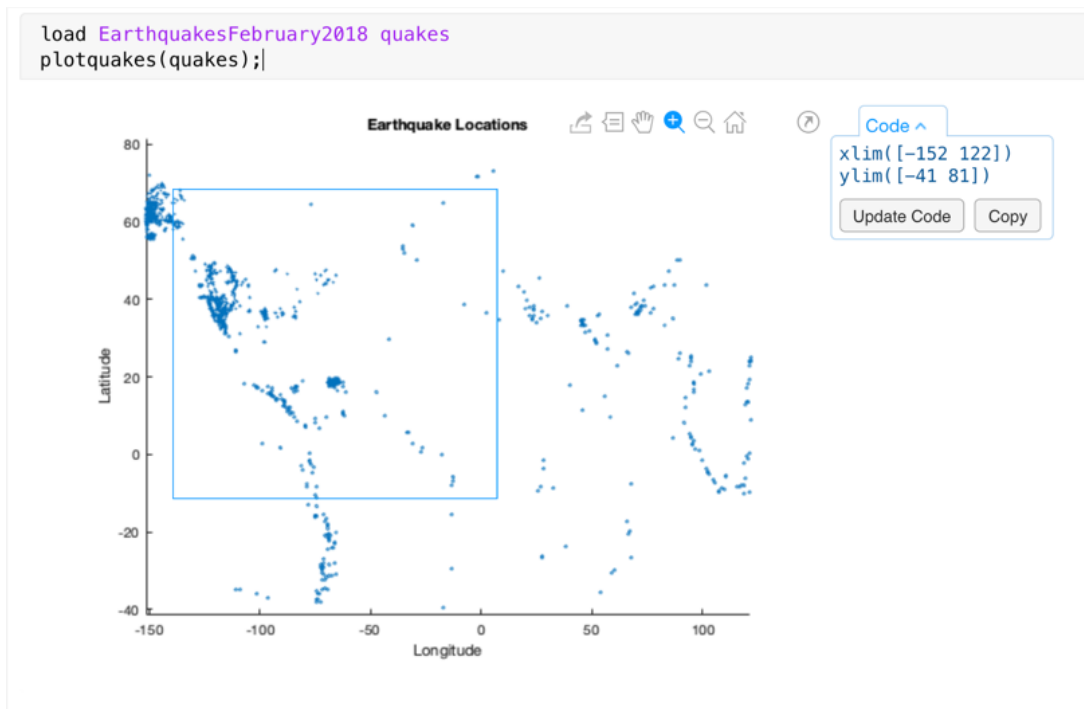
3  minmagnitude = 5;
4  theseQuakes = quakes(quakes.Magnitude > minmagnitude,:);
5  geobubble(theseQuakes,"Latitude","Longitude","SizeVariable","Magnitude"
6  "Basemap","colorterrain");

```

UTF-8 script Ln 6 Col 31

Interactive outputs

You can interact with outputs and generate MATLAB code for your interactions. For instance, you can zoom into a plot and then automatically update your program to set the new axis limits.



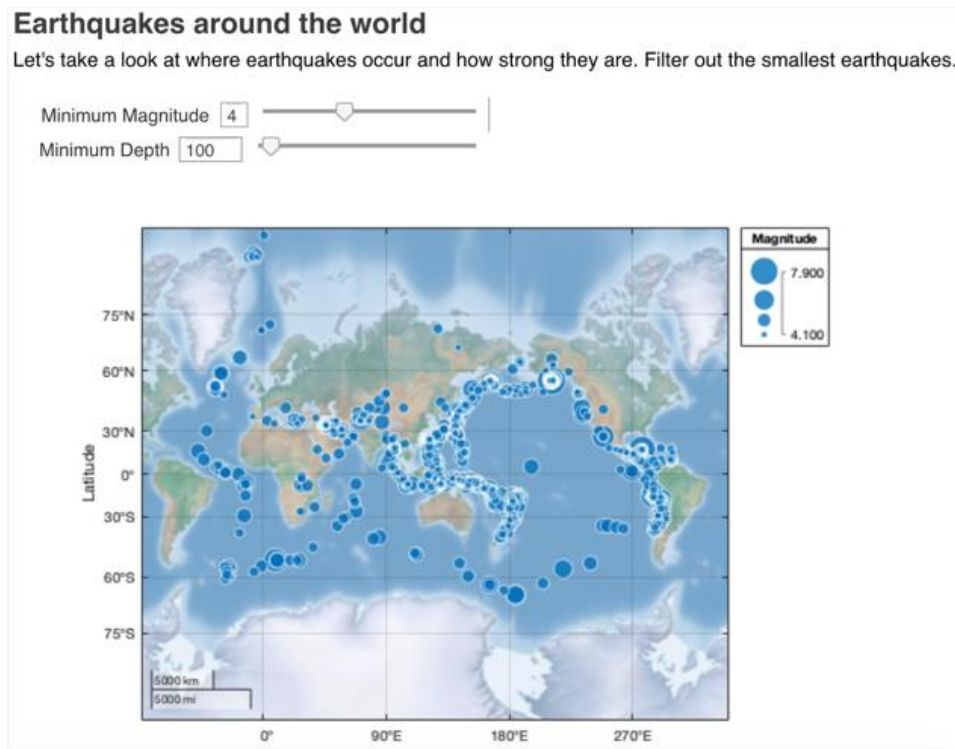
Function hints

Function hints make it easy to call functions without having to look at the documentation, and even to navigate to select files to import:

The figure shows a MATLAB function hint for the `readtimetable` function. The title is "Load energy data". The code snippet is: `energyLoad = readtimetable("Data/NYEnergyData.xlsx")`. Below the code, there is a help icon and a dropdown menu showing the function signature: `readtimetable(filename,options)` with "1 of 2" next to it. A tooltip is displayed over the `filename` argument, titled "Name of file to read". The tooltip contains two entries: "Not Using/" (with a folder icon) and "NYEnergyData.xlsx" (with a file icon).

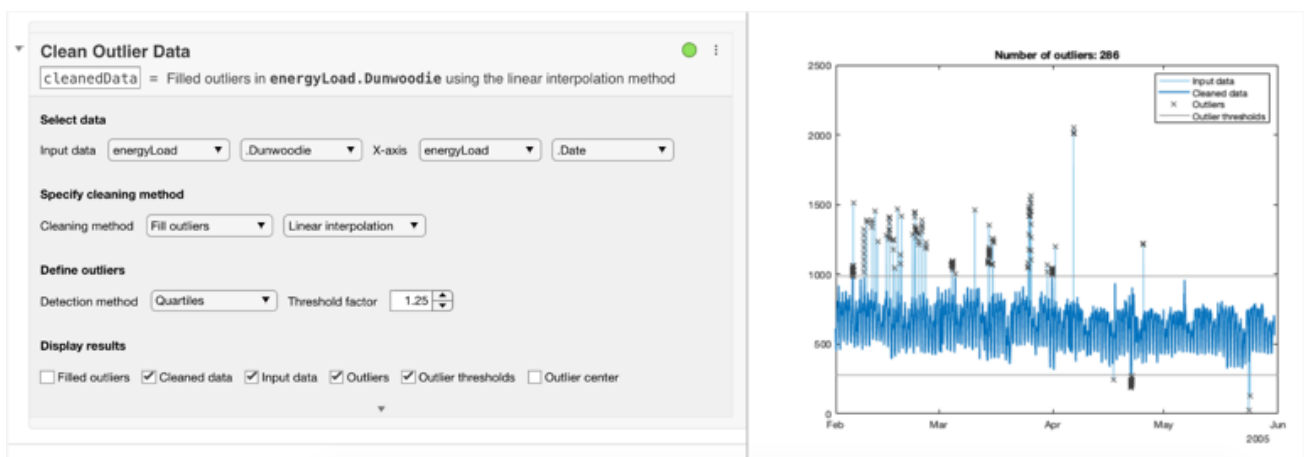
Interactive controls

You can replace the value of variables with interactive controls to make it easy to interact with your program, and even hide the code altogether:



Live Editor Tasks

You can use Live Editor tasks to preprocess data interactively and the MATLAB code is automatically written for you. There are also Live Editor tasks for working with symbolic expressions, designing control systems, and more.



Document export

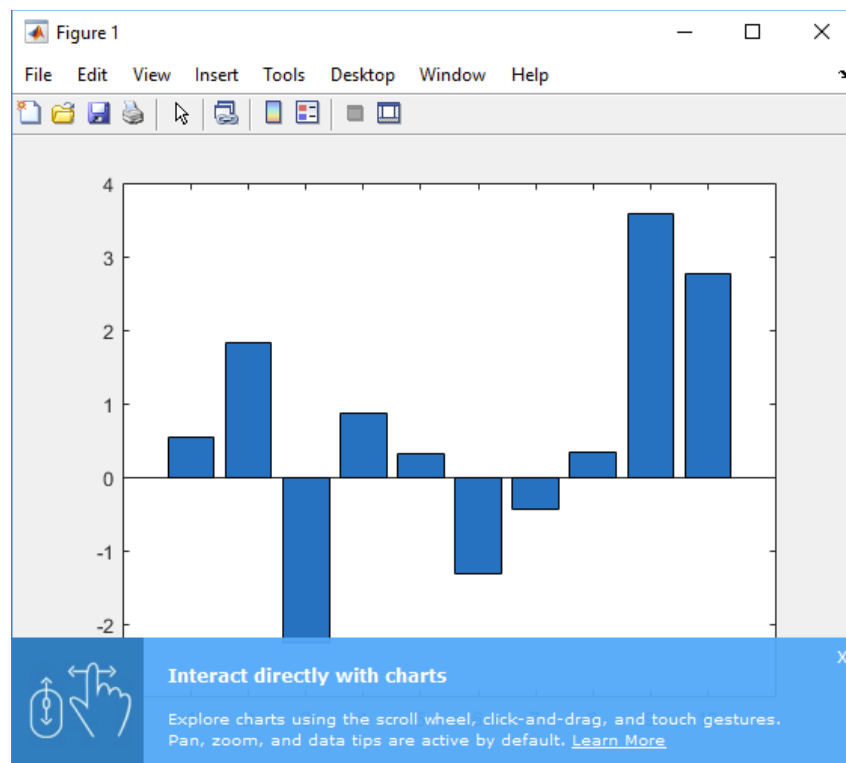
You can export your Live Scripts to PDF, Word, HTML, or LaTeX documents.

Graphics

There are a lot of new and some undiscovered graphics features. Here are just a few of our favorites:

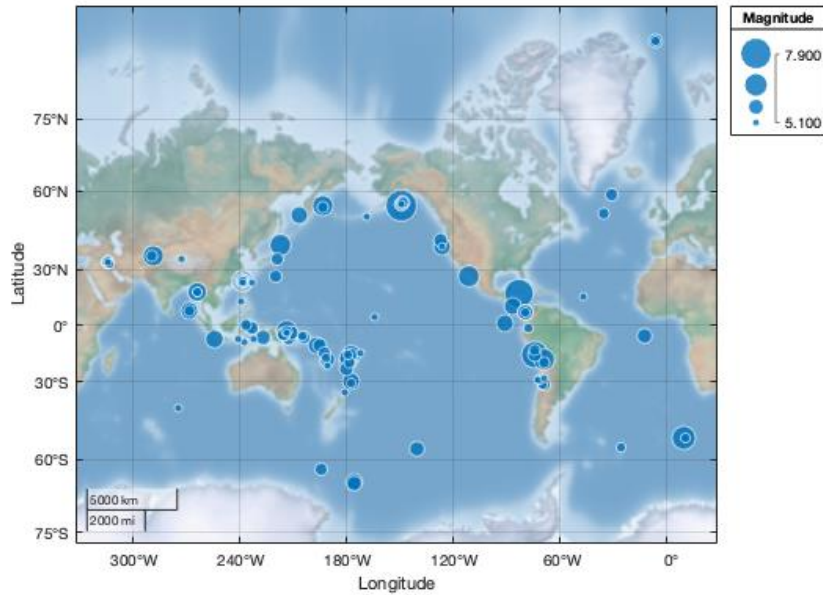
Default plot interactivity

You can use your mouse or trackpad to zoom, pan, rotate, and add datatips without having to click separate toolbar buttons first:



Geographic plots

You can now create [geographic plots](#) in MATLAB, such as this geographic bubble chart showing the location and magnitude of earthquakes around the world:



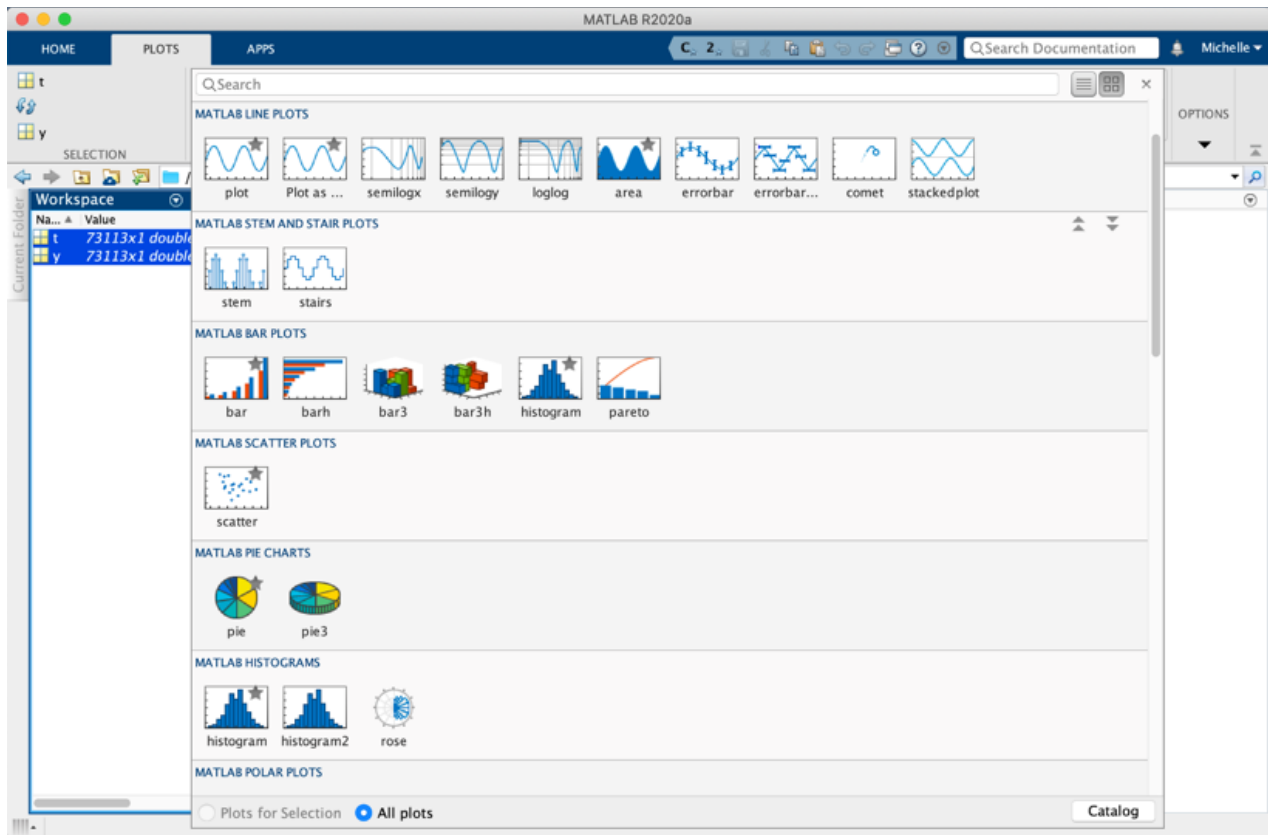
tiledlayout

You can much more easily control the layout of figures with multiple plots using [tiledlayout](#) instead of subplot.



Plots tab

You can easily plot your data with the Plots tab of the MATLAB Toolstrip. Just select your data in the Workspace browser or Variable Editor and you'll get a list of plots that work with your specific data. The equivalent MATLAB code is automatically entered in the command window for you to access later.

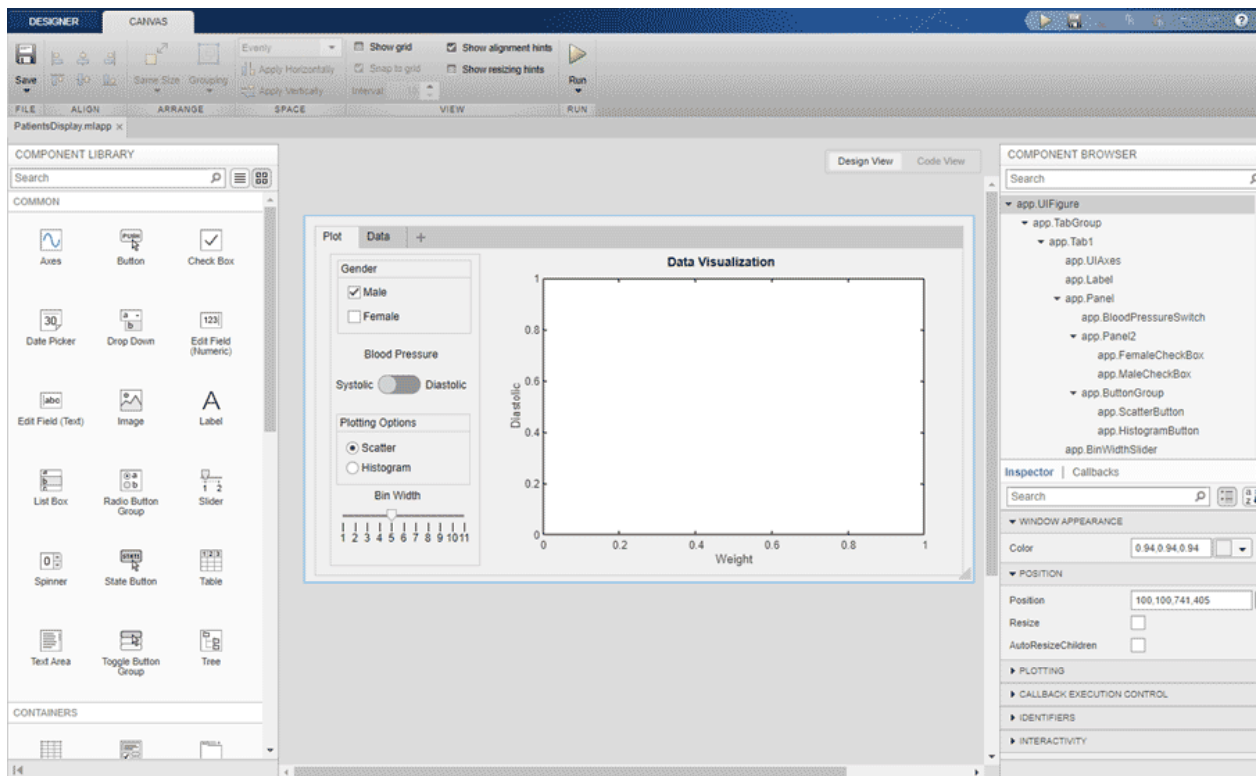


Building and Sharing Apps

You can build and share custom apps with MATLAB.

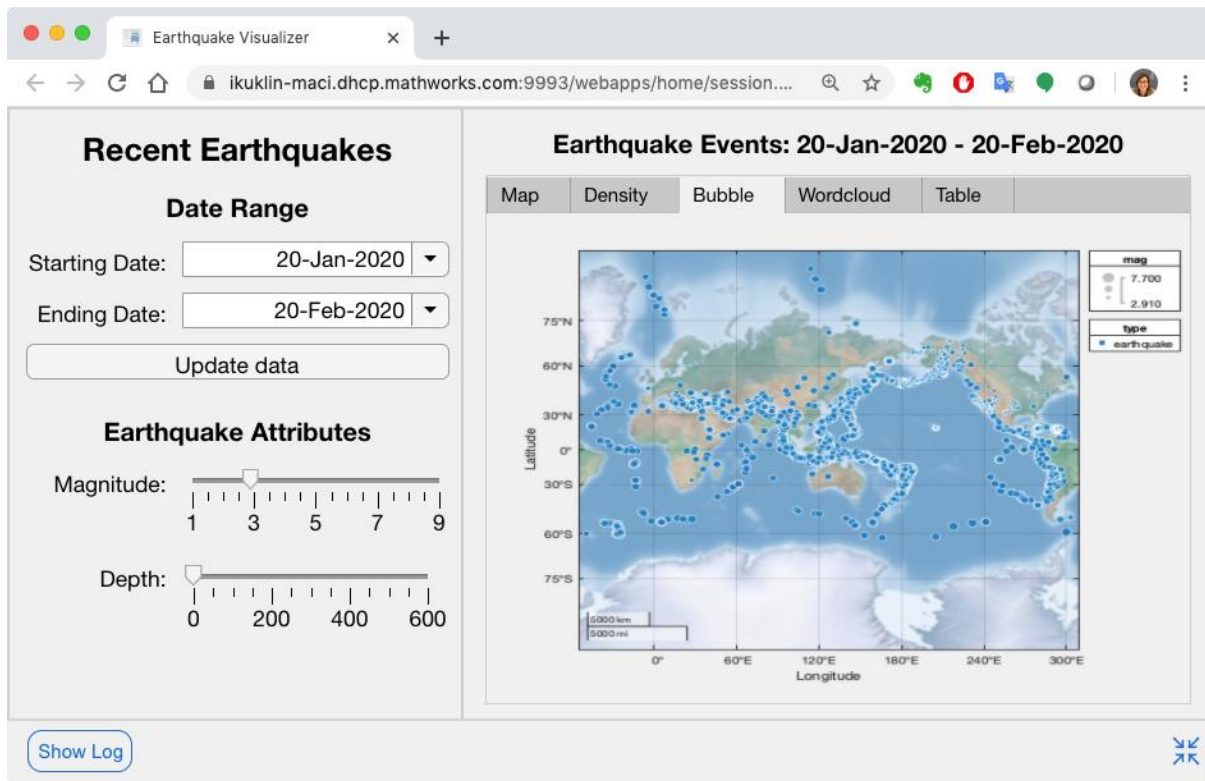
App Designer

[App Designer](#) lets you create professional apps without having to be a professional software developer. Drag and drop visual components to lay out the design of your graphical user interface (GUI) and use the integrated editor to quickly program its behavior.



Web Apps

Using the MATLAB Compiler and the [MATLAB Web App Server](#), you can share your apps as web apps that anybody in your organization can access from their web browser.

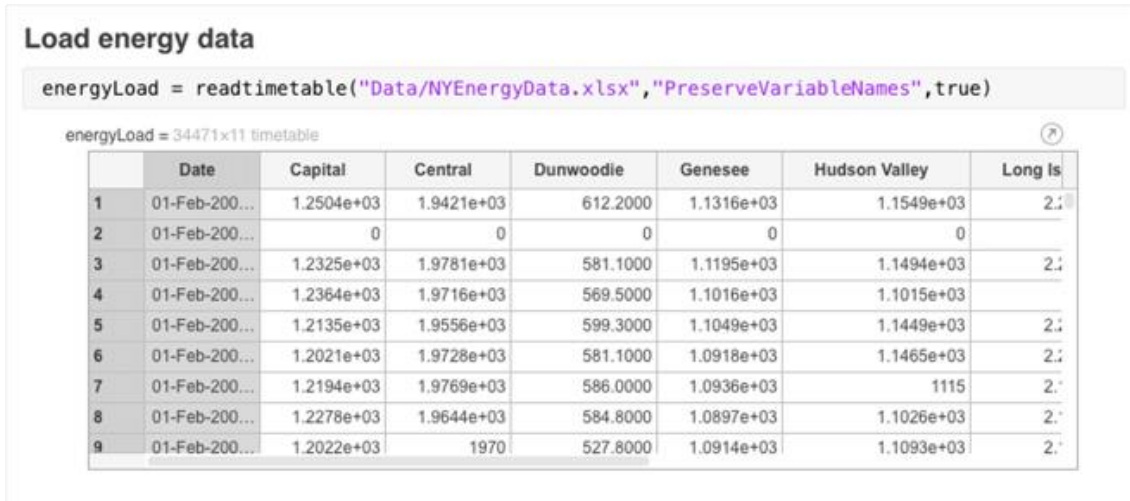


Data Preprocessing

MATLAB takes the pain out of preprocessing your data to get it ready for analysis.

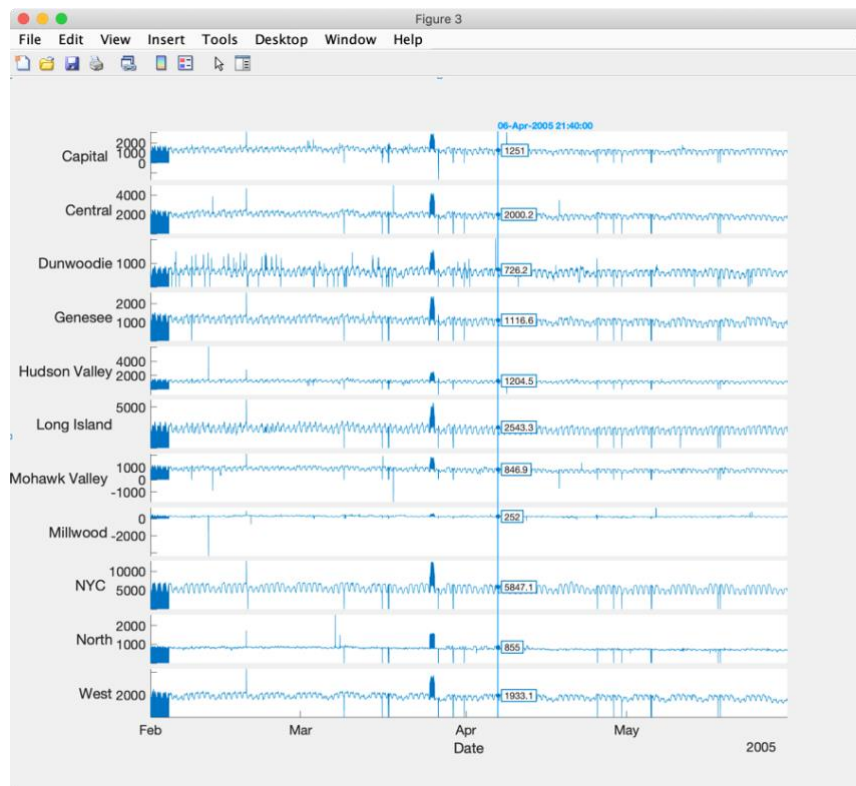
table and timetable

You can organize tabular data, such as you might store in spreadsheets, using the `table` and `timetable` data types. Timetables provide additional capabilities for managing data that varies vs. time, such as synchronizing and resampling.



stackedplot

Visualize every variable in your table or timetable with a `stackedplot`:



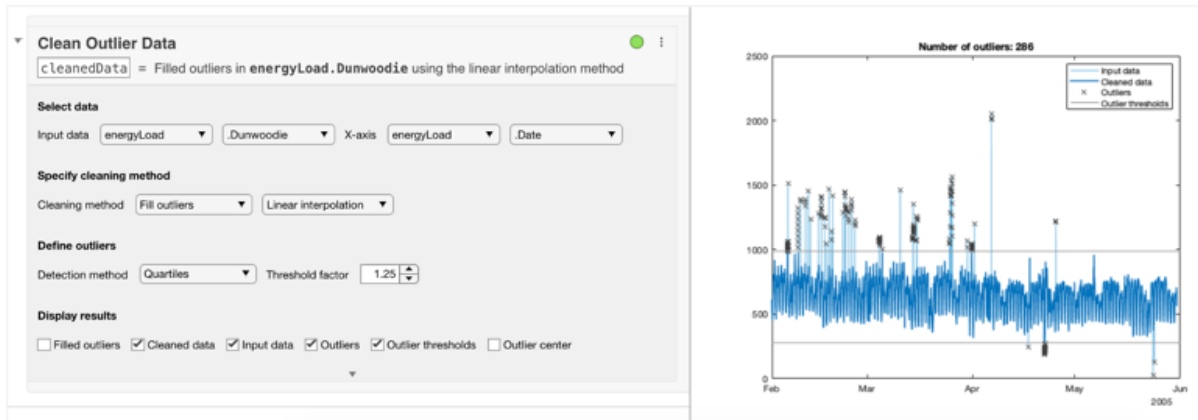
Missing data functions

Use a straightforward collection of functions for cleaning up missing data and outliers:

Functions expand all	
Missing Data and Outliers	
<code>ismissing</code>	Find missing values
<code>rmmissing</code>	Remove missing entries
<code>fillmissing</code>	Fill missing values
<code>missing</code>	Create missing values
<code>standardizeMissing</code>	Insert standard missing values
<code>isoutlier</code>	Find outliers in data
<code>filloutliers</code>	Detect and replace outliers in data
<code>rmoutliers</code>	Detect and remove outliers in data
<code>movmad</code>	Moving median absolute deviation

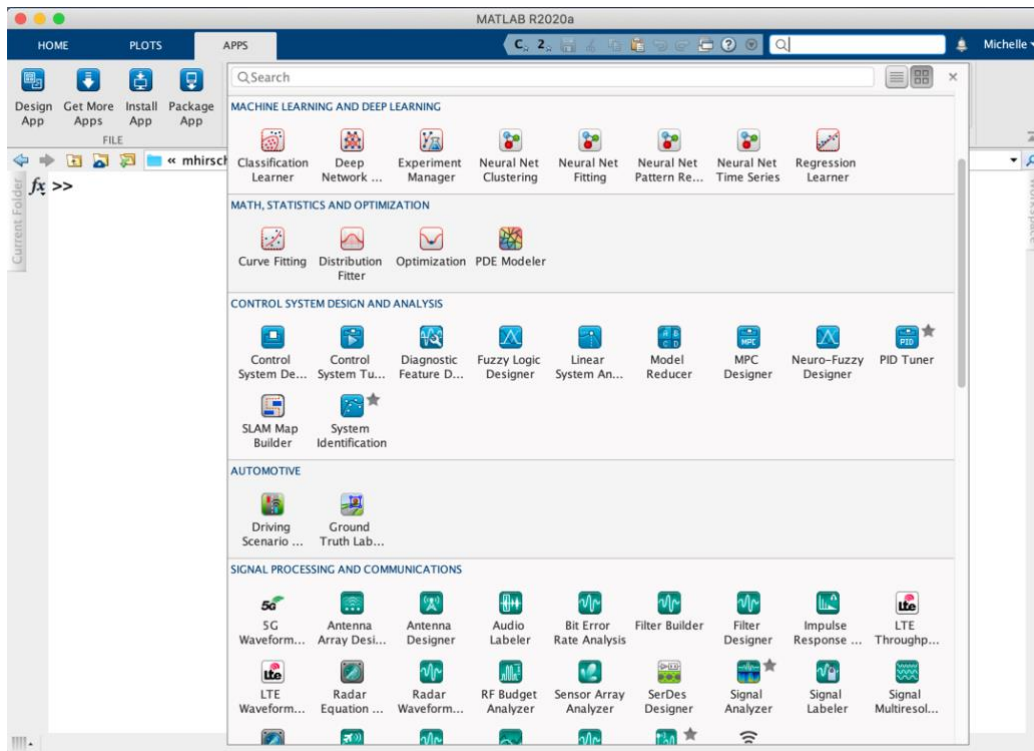
Preprocessing Live Editor Tasks

As mentioned above, you can use Live Editor tasks to preprocess data interactively and the MATLAB code is automatically written for you.



Apps

Even though a programming language is the heart of MATLAB, you don't have to write code to complete common tasks in MATLAB. You can design control systems or deep neural networks, analyze signals or radar waveforms, process images and videos, and so much more, without writing a single line of code. Even better - they write the code for you, so you don't have to choose between the ease and speed of using an app and the automation and flexibility of writing a program. Here are some of the almost 100 different [MATLAB Apps](#) available on the Apps tab of the MATLAB Toolstrip:



Hardware support

MATLAB and Simulink connect to the hardware you use, whether you want to capture images from a webcam or a high-end IP camera, automatically generate real-time C code for rapid prototyping or deploying on an embedded processor, or give students hands-on experiences for project-based learning. Find and install hardware support directly within MATLAB:

The screenshot shows the MATLAB Add-On Explorer window. The title bar reads "Add-On Explorer" and includes "Contribute" and "Manage Add-Ons" buttons. A search bar contains "Clear Filters" and "Search for add-ons". On the left, there are filter sections: "Filter by Source" (MathWorks: 185, Community: 123), "Filter by Category" (Using MATLAB: Data Import and Analysis: 6, Graphics: 1, External Language Interfaces: 1; Applications: Science and Industry: 12, Image Processing and Computer Vision: 26, Signal Processing: 30, Wireless Communications: 7, Control Systems: 1, Autonomous Systems: 16, Hardware, IoT, and Test & Measurement: 192; Using Simulink: Simulink: 32, Real-Time Simulation and Testing: 1, Physical and Event-Based Modeling: 5, Code Generation: 47, Verification, Validation, and Test: 4), "Filter by Type" (Toolboxes and Products: 21, Apps: 3, Simulink Models: 44, Hardware Support Packages: 308, Optional Features: 3, Functions: 71), and "Filter by Hardware Type" (Audio: 10, CAN Devices: 4, Data Acquisition Devices: 6, FPGA: 7, GPU: 3). The main area displays "308 RESULTS" and "Hardware Support Packages (308)". A grid of nine packages is shown, each with an image, title, description, and download count. The "MATLAB Support Package for USB Webcams" package is marked as "Installed".

Package Name	Description	Downloads	Rating
MATLAB Support Package for Arduino Hardware	Acquire inputs and send outputs on Arduino boards	1740	★★★★★
Legacy MATLAB and Simulink Support for Arduino	MATLAB class and Simulink blocks for communicating with an Arduino microcontroller board	1132	★★★★★
Simulink Support Package for Arduino Hardware	Run models on Arduino boards.	1025	★★★★★
MATLAB Support Package for USB Webcams	Acquire images and video from UVC compliant webcams.	460	★★★★★
Communications Toolbox Support Package for RTL-SDR Radio	Acquire RF data using RTL-SDR.	444	★★★★★
Image Acquisition Toolbox Support Package for OS Generic Video Interface	Acquire video and images from generic video capture devices.	423	★★★★★

Add-On Explorer

Download, install, and use add-ons without leaving the MATLAB environment, using the [Add-On Explorer](#). Whether you need additional toolboxes, apps, hardware support packages, or community submissions, you can easily browse and find what you're looking for.

The screenshot displays the MATLAB Add-On Explorer window. At the top, there is a search bar with the text "Search for add-ons" and a search icon. Below the search bar, there are two tabs: "Contribute" and "Manage Add-Ons".

On the left side, there is a sidebar with the following sections:

- Filter by Source:** Community (37,835)
- Filter by Category:**
 - Using MATLAB:**
 - Get Started with MATLAB: 27
 - Language Fundamentals: 923
 - Data Import and Analysis: 1,048
 - Mathematics: 1,410
 - Graphics: 1,875
 - Programming: 402
 - App Building: 416
 - Software Development Tools: 150
 - External Language Interfaces: 445
 - Environment and Settings: 134
 - Installation, Licensing, and Activation: 13
 - Parallel Computing: 131
 - Application Deployment: 63
 - Database Access and Reporting: 121
 - Applications:**
 - Science and Industry: 3,531
 - Image Processing and Computer Vision: 2,412
 - AI, Data Science, and Statistics: 1,483
 - Signal Processing: 1,564
 - Wireless Communications: 696
 - RF and Mixed Signal: 117
 - Math and Optimization: 1,009
 - Control Systems: 912
 - Autonomous Systems: 205
 - Hardware, IoT, and Test & Measurement: 481
 - Games: 519
 - Using Simulink:**
 - Simulink: 400
 - Simulation Graphics and Reporting: 20
 - Real-Time Simulation and Testing: 35

The main content area is divided into three sections:

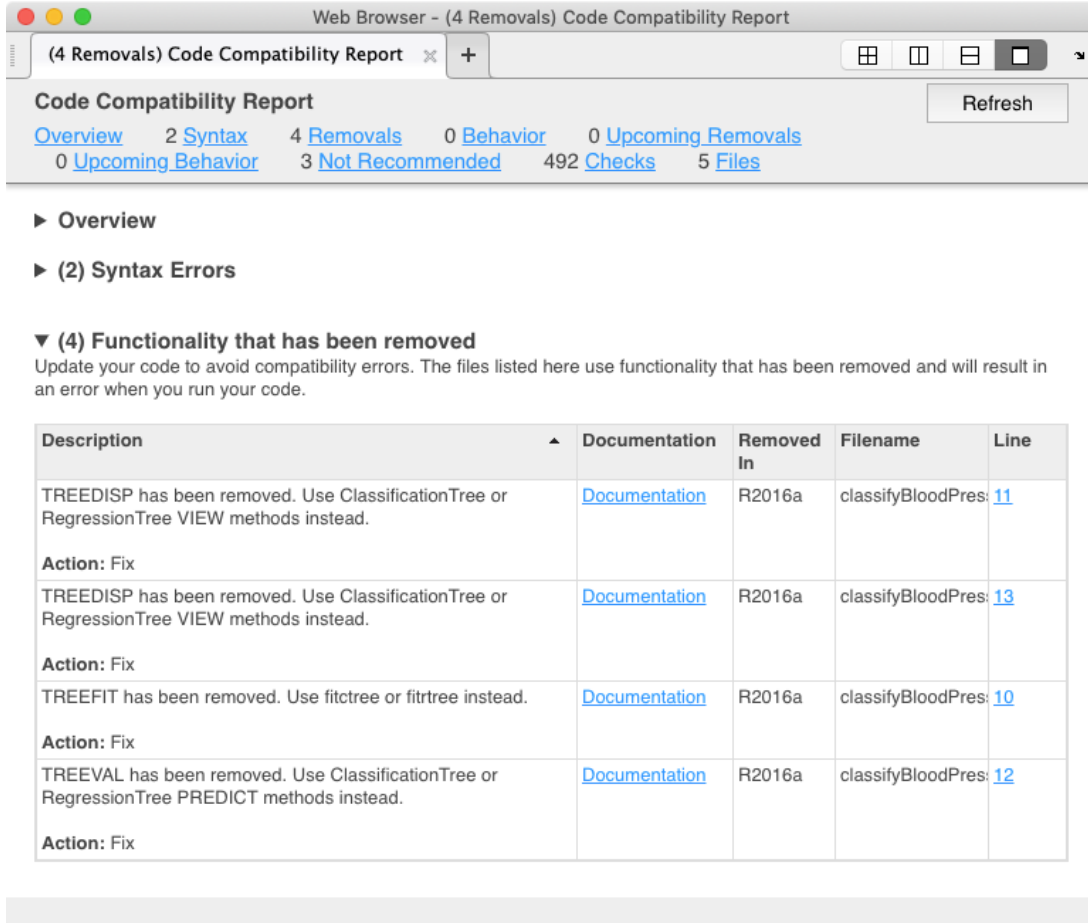
- Community Toolboxes:** Shows three items:
 - Simulink Onramp:** Learn the basics of how to create, edit, and simulate Simulink models through an interactive tutorial. 1809 Downloads, 5 stars.
 - GUI Layout Toolbox:** Layout manager for MATLAB graphical user interfaces. 1158 Downloads, 5 stars. Status: Installed.
 - Numerical Computing with MATLAB:** Toolbox containing files and app from Numerical Computing with MATLAB. 830 Downloads, 5 stars.
- Community Apps:** Shows three items:
 - PID Controller Simulator:** PID controller simulator on an LTI system w/ or w/o input delays. 716 Downloads, 5 stars.
 - Transfer Learning:** Transfer Learning of Pre-trained Neural Network or Imported ONNX Classification Model in GUI. 410 Downloads, 5 stars.
 - Aircraft Intuitive Design (AID):** An academic tool intended to assist in developing an intuitive understanding of aircraft design. 383 Downloads, 5 stars.
- Community Simulink Models:** Shows three items, including a Simulink model of a car and a Simulink model of a person.

Programming

We barely scratched the surface on programming, but touched on a few of our favorite tools that make programming easier:

Code Compatibility Report

You can run the [Code Compatibility Report](#) to analyze compatibility of your code. This report helps you identify and address any potential compatibility issues, and estimate the effort required (if any) to upgrade to a newer MATLAB release.



Code Compatibility Report Refresh

[Overview](#) 2 [Syntax](#) 4 [Removals](#) 0 [Behavior](#) 0 [Upcoming Removals](#)
0 [Upcoming Behavior](#) 3 [Not Recommended](#) 492 [Checks](#) 5 [Files](#)

► **Overview**

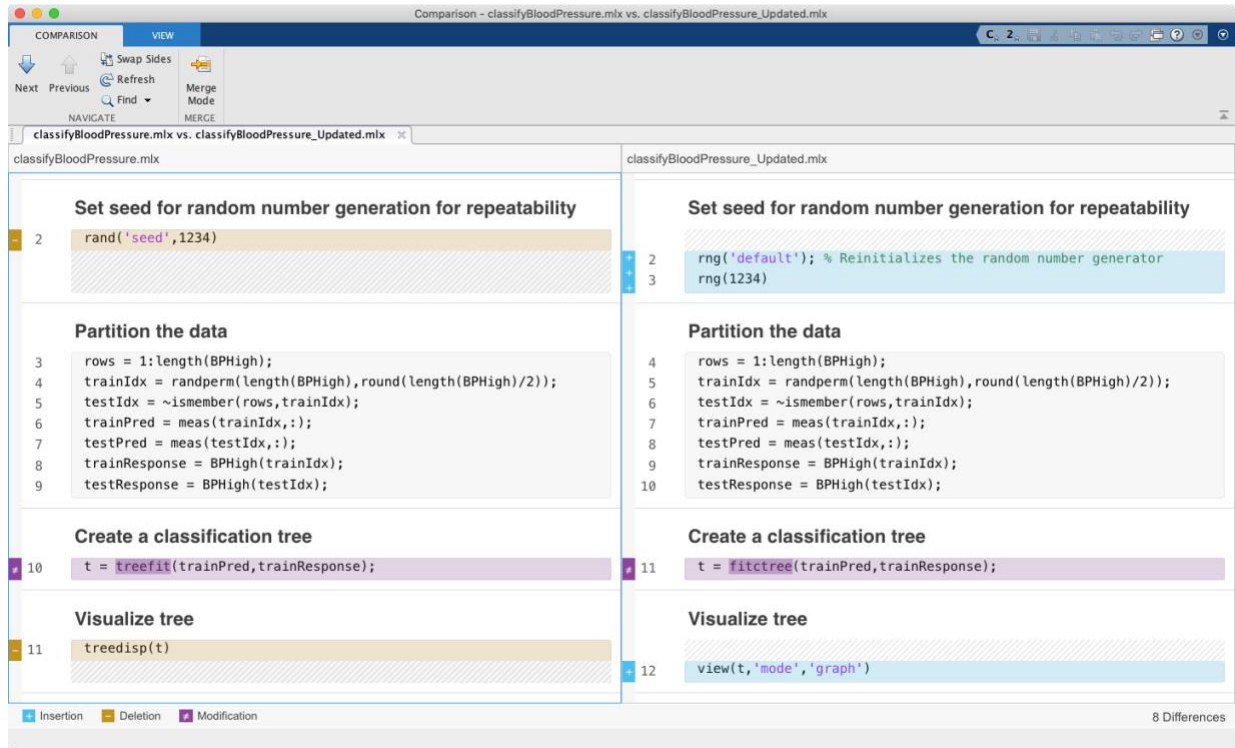
► **(2) Syntax Errors**

▼ **(4) Functionality that has been removed**
Update your code to avoid compatibility errors. The files listed here use functionality that has been removed and will result in an error when you run your code.

Description	Documentation	Removed In	Filename	Line
TREEDISP has been removed. Use ClassificationTree or RegressionTree VIEW methods instead. Action: Fix	Documentation	R2016a	classifyBloodPres:	11
TREEDISP has been removed. Use ClassificationTree or RegressionTree VIEW methods instead. Action: Fix	Documentation	R2016a	classifyBloodPres:	13
TREEFIT has been removed. Use fitctree or fitrtree instead. Action: Fix	Documentation	R2016a	classifyBloodPres:	10
TREEVAL has been removed. Use ClassificationTree or RegressionTree PREDICT methods instead. Action: Fix	Documentation	R2016a	classifyBloodPres:	12

File Comparison Tool

Compare two versions of a program and merge changes using the [File Comparison Tool](#).



Code Analyzer

Did you ever wonder what those orange and red squiggles in your code meant? These are the [Code Analyzer](#) at work, telling you about code that will definitely error when you try to run it (red), or that could potentially be improved (orange).

```
% Find input indices that are not line objects
nothandle = ~ishandle(hline);
for nh = 1:prod(size(hline))
    notline(nh) = ~ishandle(hline(nh)) || ~strcmp('line', lower(get(hline(nh), 'type')));
end
% Use STRCMP1(str1,str2) instead of using UPPER/LOWER in a call to STRCMP. Fix

len = zeros(size(hline));
for nl = 1:prod(size(hline))
    % If it's a line, get the data and compute the length
    if ~notline(nl)
        flds = get(hline(nl));
        fdata = {'XData', 'YData', 'ZData'};
        for nd = 1:length(fdata)
            data{nd} = getfield(flds, fdata{nd});
        end
        % If there's no 3rd dimension, or all the data in one dimension is
        % unique, then consider it to be a 2D line.
        if isempty(data{3}) || ...
```

Multi-release Release Notes

We know it's hard to keep up with so many great new capabilities released twice a year, every year. That's why we've given you more control over the [release notes](#), so you can view all of the changes for a given section of MATLAB or add-on product across a range of releases.

The screenshot shows a web browser window with the URL 'MATLAB Release Notes'. The page has a blue header with 'Documentation' and a search bar. On the left, there is a 'CONTENTS' sidebar with a 'Category' section where 'Graphics' is selected. Below the sidebar, there are sections for 'Text Filter' and 'Release Range' set to 'R2018b' to 'R2020a'. The main content area shows 'MATLAB Release Notes' with sub-sections for 'Bug Reports' and 'Bug Fixes'. It indicates 'Found 53 notes' and is sorted by 'Release: Latest to Earliest'. The notes are grouped by release: R2020a, R2019b, R2019a, and R2018b, each with a link to 'New Features, Bug Fixes, Compatibility Considerations'. At the bottom, there is a feedback section asking 'How useful was this information?' with five star icons.