What’s New in MATLAB

Will Wilson
Application Engineer
MathWorks
Agenda

- MATLAB Infrastructure
  - Editor
  - Graphics
  - Execution Engine

- Data Handling
  (e.g., importing, datatypes, big data)

- Workflows
  - Managing / Testing Code
  - Sharing Apps and Custom Toolboxes

- Hardware Support
Live Editor

Modes
- Accelerate exploratory programming
- Create an interactive narrative
- Teach with interactive documents

Symbolic Math Toolbox support
- Alternate for MuPAD notebooks
- Typeset equations
New Graphics System

- **New look**
  - New default colormap and line colors
  - Anti-aliased fonts and lines
  - Subtler grid lines

- **Easier to customize**
  - Graphics objects now behave like other MATLAB objects
  - Support dot-notation to access and change properties

```matlab
>> p = plot(x, y);
>> p.Color = 'red';
```
New Graphics System

- Rotatable tick labels
- Automatic updating of datetime tick labels
- New visualization functions
  - histogram
  - animatedline
- Multiple colormaps per figure
- Multilingual text and symbols
- User interfaces with tab panels
More Graphics Features

- **polarplot**
  - Including negative radial axis limits
- **Family of parametric plotting functions**
  - `fplot`
  - `fplot3`
  - `fcontour`
  - `fsurf`
  - `fmesh`

```matlab
theta = linspace(0,2*pi);
rho = sin(theta);
polarplot(theta,rho)
```

Change the limits of the r-axis so it ranges from -1 to 1.

```matlab
rlim([-1 1])
```
MATLAB Execution Engine

- Redesigned **execution engine** runs MATLAB code faster
  - All MATLAB code is now JIT compiled
  - A platform for future improvements

- Average performance improvement of **40%** on **76 performance-sensitive user applications**
  - Function call overhead is lower
  - Many object-oriented features are faster
  - Some element-wise operations are faster

- Learn more
Agenda

- MATLAB Infrastructure
  - Editor
  - Graphics
  - Execution Engine

- Data Handling
  (e.g., importing, datatypes, big data)

- Workflows
  - Managing / Testing Code
  - Sharing Apps and Custom Toolboxes

- Hardware Support
Import Tool

- Interactive import of delimited and fixed-width text files
- Improved handling of:
  - Numbers
  - Text
  - Dates
- Define rules for handling nonnumeric values
- Automatically generate MATLAB code (scripts and functions) to automate the process
Tables

- New fundamental data type
- For mixed-type tabular data
  - Holds both data and metadata
- Supports flexible indexing
- Built-in functionality (merge, sort, etc.)
Categorical Arrays

- New fundamental data type
- For discrete non-numeric data
  - Values drawn from a finite set of possible values ("categories")
- More memory efficient than a cell array of strings
- Can be compared using logical operators
  - Similar to numeric arrays
Date and Time Arrays

- `datetime` for representing a point in time
- `duration`, `calendarDuration` for representing elapsed time
- Same data type for computation and display
  - Add, subtract, sort, compare, and plot
  - Customize display formats
  - Nanosecond precision
- Support for time zones
  - Accounts for daylight saving time
Graphs and Network Algorithms

- Graphs model the connections in a network
  - Widely applicable in physical, biological, and information systems

- Two new functions for creating graphs
  - `graph` (undirected graphs)
  - `digraph` (directed graphs)

- Graph objects work just like other MATLAB objects

- Multiple graph layouts available (circular, force-directed, tiered)

- New functions available for working with graphs
  - `shortestpath, shortestpathtree, minspantree, distances`
  - *(and many others)*
Split-Apply-Combine Workflow

- Two new functions to support this workflow
  - `findgroups` – splits the data into groups
  - `splitapply` – applies a function to each group, and combines the results

```
G = findgroups(Gender)
meanHeight = splitapply(@(mean, Height, G)
```

<table>
<thead>
<tr>
<th>LastName</th>
<th>Height</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>'Williams'</td>
<td>64</td>
<td>'Female'</td>
</tr>
<tr>
<td>'Smith'</td>
<td>72</td>
<td>'Male'</td>
</tr>
<tr>
<td>'Jones'</td>
<td>67</td>
<td>'Female'</td>
</tr>
<tr>
<td>'Johnson'</td>
<td>69</td>
<td>'Male'</td>
</tr>
<tr>
<td>'Brown'</td>
<td>64</td>
<td>'Female'</td>
</tr>
<tr>
<td>'Davis'</td>
<td>68</td>
<td>'Female'</td>
</tr>
</tbody>
</table>

```
G
1 1 2 2 1
```

```
Female
64 67 64 68
```

```
Male
72 69
```

```
meanHeight
65.750 70.500
```
Big Data Capabilities in MATLAB

Memory and Data Access
- 64-bit processors
- Memory Mapped Variables
- Disk Variables
- Databases
- Datastores
  - datastore
  - imageDataStore

Programming Constructs
- Streaming
- Block Processing
- Parallel-for loops
- GPU Arrays
- SPMD and Distributed Arrays
- MapReduce

Platforms
- Desktop (Multicore, GPU)
- Clusters
- Cloud Computing (MDCS on EC2)
- Hadoop
Access Big Data **(datastore)**

- Easily specify data set
  - Single text file (or collection of text files)
  - Database (using Database Toolbox)

- Preview data structure and format

- Select data to import using column names

- Incrementally read subsets of the data

```matlab
airdata = datastore('*\.csv');
airdata.SelectedVariables = {'Distance', 'ArrDelay'};
data = read(airdata);
```
Agenda

- MATLAB Infrastructure
  - Editor
  - Graphics
  - Execution Engine

- Data Handling
  (e.g., importing, datatypes, big data)

- Workflows
  - Managing / Testing Code
  - Sharing Apps and Custom Toolboxes

- Hardware Support
Source Control Integration

- Manage your code from within the MATLAB Desktop

- Leverage modern source control capabilities
  - GIT and Subversion integration in Current Folder browser

- Use Comparison Tool to view and merge changes between revisions
Pause Button in Classic Editor/Debugger
Unit Testing Framework

- Write, run, and analyze tests for your MATLAB programs
  - Define how each test checks values and responds to failures
  - Setup and restore system before and after tests
  - Run tests individually or grouped into a test suite
  - Measure MATLAB code performance

- Supports either script-based, function-based or object-based unit tests
MATLAB Apps

- Apps are self-contained tools, typically with a UI
  - Accessed in MATLAB Apps gallery
  - Included in many MATLAB Products
  - Can be authored by MATLAB users

- Apps from the MATLAB Community
  - Found on MATLAB File Exchange
  - Download and install into the MATLAB Apps gallery

- Making your own apps
  - Create single file for easier install and distribution
Toolbox Packaging

- Package your toolbox as a single installer file
  - Contains all of the code, data, apps, documentation, and examples
  - Checks for dependent files and automatically includes them
  - Documents required products

- Included folders and files automatically appear on path when installed

- View details and uninstall toolboxes with Manage Add-on Toolboxes dialog box
MATLAB Documentation

- Integration of documentation for custom toolboxes into the MATLAB Help Browser
  - Link appears on the Home Help page
  - Help displays in the current window
  - Integrated search

- Redesigned help navigation
### MATLAB Compiler
- Application-specific MATLAB Runtime based on requirements for numeric, graphic, and GPU support
- Support for MATLAB objects for Hadoop integration

### MATLAB Compiler SDK
- Development and test framework for MATLAB Production Server for integration with web and enterprise systems
Agenda

- MATLAB Infrastructure
  - Editor
  - Graphics
  - Execution Engine

- Data Handling
  (e.g., importing, datatypes, big data)

- Workflows
  - Managing / Testing Code
  - Sharing Apps and Custom Toolboxes

- Hardware Support
MATLAB Hardware Support Packages

- **Raspberry Pi / Pi 2**
  - Capture live data from sensors and imaging devices
  - Connect to MATLAB over Ethernet (wired or wireless)

- **Webcams**
  - Preview and acquiring live images

- **Arduino / BeagleBone Black**
  - Control DC, servo and stepper motors
  - Acquire data (analog / digital, I2C or SPI sensors and peripherals)

- **Android & iOS Sensors**
  - Stream sensor data and import GPS location data
  - Works with MATLAB Mobile

- **Lego EV3**
  - Control Lego EV3 motors
  - Determine motion/path of robot from sensor data