MATLAB for Computational Finance
and what’s new since 2012b

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Agenda

- MATLAB
- Help System
- MATLAB for Production
- Parallel & GPU Computing
- Computational Finance
- Optim & Stats
- Connecting to Low Cost Hardware
MATLAB
Introducing the New MATLAB Desktop
MATLAB Toolstrip
Find what you need

- Tabs organize commonly used functionality
  - Key features placed up front
  - Design optimized for common tasks

- Functionality only appears when needed
Quick Access Toolbar

- Place to put commonly used commands
- Any item from a tab or shortcuts can be added to the toolbar
- Remains visible when the toolstrip is minimized
MATLAB Apps
MATLAB Apps
What are MATLAB Apps?

- Interactive MATLAB programs that include a GUI
- Apps are included in many MATLAB products
- There are also many user-written apps
MATLAB Apps Gallery

- Tab within the MATLAB Toolstrip
- Prominently displays both user-written apps and apps included in MATLAB products
- Makes it easy to find and launch MATLAB apps
Packaging and Sharing MATLAB Apps

- Automatically includes all necessary files
- Documents required products
- Creates single installation file for easy distribution and installation into the MATLAB apps gallery
Command Line Suggestions

- Suggested corrections offered for mistyped functions and variables in the command window

- Press Enter to execute the suggested command, or Esc to delete it
### Getting More Apps

#### MATLAB Apps

<table>
<thead>
<tr>
<th>Math, Statistics, and Optimization Apps</th>
<th>AVAILABLE IN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Curve Fitting</strong></td>
<td>Curve Fitting Toolbox</td>
</tr>
<tr>
<td>Fits curves and surfaces to data.</td>
<td></td>
</tr>
<tr>
<td><strong>Distribution Fitting</strong></td>
<td>Statistics Toolbox</td>
</tr>
<tr>
<td>Fit probability distributions to data</td>
<td></td>
</tr>
<tr>
<td><strong>MBC Model Fitting</strong></td>
<td>Model-Based Calibration Toolbox</td>
</tr>
<tr>
<td>Create experimental designs and statistical models for model-based calibration</td>
<td></td>
</tr>
<tr>
<td><strong>MBC Optimization</strong></td>
<td>Model-Based Calibration Toolbox</td>
</tr>
<tr>
<td>Generate optimal lookup tables for model-based calibration</td>
<td></td>
</tr>
<tr>
<td><strong>MuPad Notebook</strong></td>
<td>Symbolic Math Toolbox</td>
</tr>
<tr>
<td>Perform and document symbolic calculations</td>
<td></td>
</tr>
<tr>
<td><strong>Neural Net Clustering</strong></td>
<td>Neural Network Toolbox</td>
</tr>
<tr>
<td>Solve clustering problems using self-organizing map (SOM) networks</td>
<td></td>
</tr>
<tr>
<td><strong>Neural Net Fitting</strong></td>
<td>Neural Network Toolbox</td>
</tr>
<tr>
<td>Solve fitting problems using two-layer feed-forward networks</td>
<td></td>
</tr>
</tbody>
</table>
Import Tool

- Interactive import of delimited and fixed-width text files
- Improved handling of:
  - Mixed numeric and text data
  - Dates
- Define rules for handling nonnumeric values
- Automatically generate MATLAB code (scripts and functions) to automate the process
Command Line Suggestions

- Suggested corrections for mistyped functions and variables in the Command Window
- Press Enter to execute the suggested command, or Esc to delete it
MATLAB
Unit Testing Framework

- `matlab.unittest` package

- xUnit-style testing framework for the MATLAB language
  - Allows writing and running unit tests, and analyzing test results
  - Includes a set of readily available qualification methods
  - Supports automation, and provides easy reuse of test-cases
MATLAB

table Data Type

- A new fundamental data type in MATLAB
- Container for mixed-type tabular data
  - Holds both data and metadata
- Supports flexible indexing
- Built-in functionality (merge, sort, etc.)

>> tableDataImp
MATLAB Categorical Arrays

- A new fundamental data type in MATLAB
- Container 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)
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Documentation Center and Redesigned Help

- Content organized by topic rather than content type
- Browser-like interface, with improved search
  - Facets allow users to filter search results
  - Multiple tabs
- Documentation installed locally
  - Option to use the online Documentation Center
  - Demos are now "Examples"
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MATLAB Production Server

- Incorporate numerical analytics (as packaged MATLAB programs) into enterprise applications

- Framework contains:
  - Server software
    - Manages packaged MATLAB programs and worker pool
  - Runtime libraries
    - MATLAB Compiler Runtime (MCR)
  - Lightweight client library (.NET & Java)
    - Make requests of MATLAB Production Server

New Product
Centralizing Analytics with MPS

MATLAB Compiler

Web Server

MATLAB Production Server

Portfolio Optimization

Pricing

Risk Analytics

Database Server

Web Applications

Desktop Applications

Batch Applications
MATLAB Production Server

- Directly deploy MATLAB programs into production
  - Centrally manage multiple MATLAB programs & MCR versions
  - Automatically deploy updates without server restarts

- Scalable & reliable
  - Service large numbers of concurrent requests
  - Add capacity or redundancy with additional servers

- Use with web, database & application servers
  - Lightweight client library isolates MATLAB processing
  - Access MATLAB programs using native data types
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Parallel Computing toolbox

- Supports unlimited workers
  - Previously 12
GPU Support with Parallel Computing Toolbox

- NVIDIA GPUs with compute capability 1.3 or greater
  - (e.g., NVIDIA Tesla C2075 or K20)

- Why we require compute capability 1.3
  - Support doubles (base data type in MATLAB)
  - Guarantee IEEE compliance
  - Provide cross-platform support

- Evolving rapidly – use the latest MATLAB release
New for GPU Computing with MATLAB

- **Performance**
  - Improvements to GPU-enabled MATLAB functions (e.g., random number generation for Monte Carlo simulations)

- **More GPU-enabled functions**
  - Including `convn`, `cov`, and `normest`
  - Additional support for toolboxes

New Built-in Parallel Support

- **Neural Networks Toolbox**
  - Speedup training and simulation with multicore processors, clusters, or using a GPU
  - Distributed training of large datasets on clusters

- **Signal Processing Toolbox**
  - GPU acceleration for `xcorr`, `xcorr2`, `fftfilt`, `xcov`, and `cconv`

- **Statistics Toolbox**
  - Parallel support in `kmeans` for multicore processors
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Database Explorer

- Replaces querybuilder

```matlab
dexplore
```

- Native ODBC driver
  - Fast access to ODBC
  - R2013b
Financial Instruments Toolbox

Design, price, and hedge complex financial instruments

- Merger of:
  - Financial Derivatives Toolbox + Fixed-Income Toolbox

- New features:
  - Cap and floor floating-rate note pricing using trees
  - Forward-swap pricing using trees or term structure
  - LIBOR market model example
Trading Toolbox

- Submit, Monitor, Modify orders
- Supported Brokers
  - X_Trader, EMSX, CQG, Interactive Brokers

Development and testing

Historical Data
- End of Day
- Intraday
- Files
- Databases

Strategy Modeling
- Research / Algorithms
- Model Development
- Calibration

Back Testing
- Profit / Loss
- Risk Exposure

Decision Engine
- Models
- Trading Rules

Implementation
- Live Data
  - Real-Time Feeds
  - Event-Based

Execution
- Broker API
- Order Routing
Additional Computational Finance Updates

- **Financial Toolbox**
  - Conditional Value at Risk (CVaR) portfolio solver
  - Mean-absolute deviation (MAD) portfolio optimization (R2013b)

- **Econometrics Toolbox**
  - ARIMA modeling regression objects

- **Datafeed Toolbox**
  - Added support for IQFEED

- **Financial Instruments Toolbox**
  - Calibration and Monte Carlo simulation for Hull-White, Linear Gaussian & LIBOR market models (R2013a)
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Optimization Toolbox
Mixed Integer Linear Programming MILP

Power Generation

Portfolio Management

Manufacturing / Supply Chain
Modeling case study

- **Overview**

  ![Table showing requirements and revenue per item]

<table>
<thead>
<tr>
<th>Item</th>
<th>Nuts</th>
<th>Bolts</th>
<th>Revenue per Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gadget</td>
<td>5</td>
<td>2</td>
<td>$3.00</td>
</tr>
<tr>
<td>Widget</td>
<td>3</td>
<td>8</td>
<td>$10.00</td>
</tr>
</tbody>
</table>

- **Challenge**
  - Current inventory
  - 29 nuts / 34 bolts
  - How many gadgets / widgets to make to maximize revenue?
This is an optimization problem

- **Linear Programming (LP)**
  - `linprog` provides the following answer:
    - 3.8235 gadgets
    - 3.2941 widgets
  - Could attempt to round up/down
    - 4 gadgets
    - 3 widgets

- **Mixed-Integer Linear Programming (MILP)**
  - `intlinprog` provides the following answer:
    - 1 gadgets
    - 4 widgets

$44.11$ (but not possible)

$42.00$

$43.00$
Traveling Salesman Problem

Problem
- How to find the shortest path through a series of points?

Solution
- Calculate distances between all combinations of points
- Solve an optimization problem where variables correspond to trips between two points
Other Updates

- **Statistics Toolbox**
  - Support vector machines (SVMs) for binary classification, PCA algorithms for missing data, and Anderson-Darling goodness-of-fit test (R2013a)
  - Linear mixed-effects regression models

- **Financial Toolbox**
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Connecting to Low Cost Hardware

Your application
MATLAB algorithm or Simulink model

Data I/O
Ethernet / USB / Bluetooth

Low cost hardware

- MATLAB Support Package for Raspberry Pi™
- Webcam support package
- iPhone/Android support

TETHERED
Write code and communicate with the board